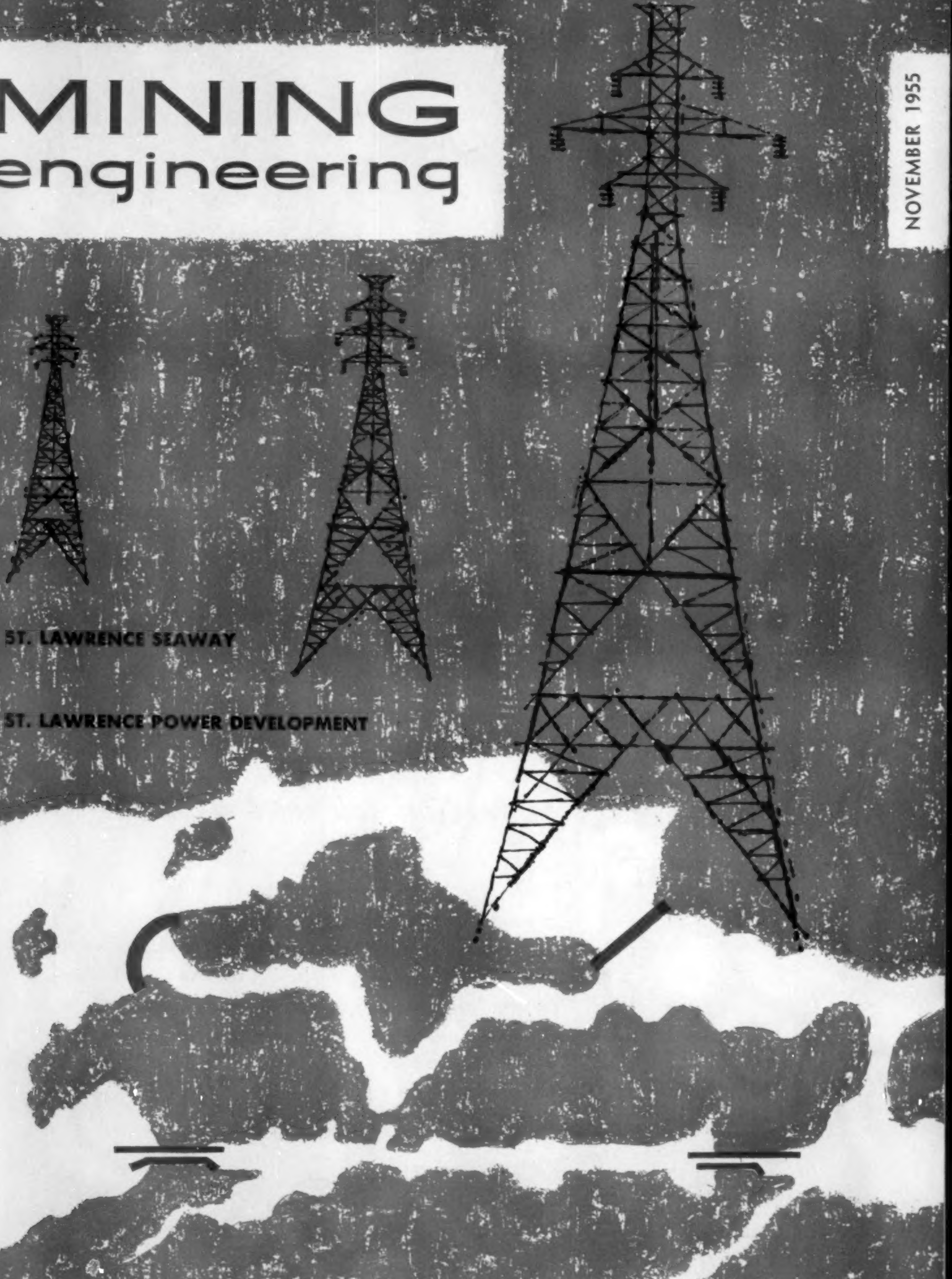
MINING engineering

NOVEMBER 1955



ST. LAWRENCE SEAWAY

ST. LAWRENCE POWER DEVELOPMENT

MINING engineering

VOL. 7 NO. 11 NOVEMBER 1955

COVER

What the St. Lawrence Development will mean to the mineral industry is yet unknown, but artist Herb McClure has picked out the two key items of interest to the industry—power and deepwater access to the sea.

FEATURES

ARTICLES

TRANSACTIONS

The AIME also publishes **Journal of Metals** and **Journal of Petroleum Technology.**

Published monthly by the American Institute of Mining and Metallurgical Engineers, Inc., 29 West 39th St., New York 18, N. Y. Telephone: PEnnsylvania 6-9220. Subscription $8 per year for non-AIME members in the U. S., & North, South & Central America; $10 foreign; $6 for AIME members, or $4 additional in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies $.75; single copies foreign $1.00, special issues $1.50. The AIME is not responsible for any statement made or opinion expressed in its publication.

Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by The National Research Bureau. Entered as second-class matter Jan. 18, 1949, at the post office at N. Y., N. Y., under the act of March 3, 1879. Additional entry established in Manchester, N. H. Member, ABC.

PERSONNEL

THE following employment items are made available to AIME members on a non-profit basis by the Engineering Societies Personnel Service Inc., operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

MEN AVAILABLE

Mining Geologist, 39, E.M. degree 1939, M.S. 1951. Underground and open pit engineering. Geological mapping and exploration. Geophysical exploration. Administration. Will locate anywhere in U.S.A. M-243-Chicago.

Mining Engineer, 33, B.S. mining geology. Six years broad general experience, mining shaft and tunnel work, heavy construction. Three years supervisory capacity. Location desired, foreign. M-244-Chicago.

POSITIONS OPEN

Chief Geologist to take charge of an exploration dept. Should have 15 to 25 years experience in field exploration and mine examination, including experience in economic analysis and evaluation of mines, properties, and prospects. Oil and gas geological experience desirable. Travel in U. S., Canada, and Alaska. Salary open. Headquarters, New York, N. Y. W2219.

Project Engineer, 25 to 35, graduate mining, metallurgical, chemical, or mechanical graduate to assist in design and development for mineral dressing, heavy chemical, cement, and rock industries. Must have had engineering and field experience and be willing to work on drafting boards, travel, and do field service. W2027(a).

Metallurgical Engineer, with B.S. in chemical, metallurgical, or mechanical engineering and at least 5 years ferrous, furnace, and foundry experience for field development and process equipment manufacturer. Considerable traveling in East and Midwest. Salary, $7200 to $8400 a year. Headquarters, New York, N. Y. W2179.

Assistant Mill Superintendent for large base metal mine in South West Africa. Should be technical graduate, with at least 5 years base metal flotation experience. Three-year contract, transportation for self and family, and salary while traveling. House furnished for married man. Climate and living conditions excellent. F2163.

Assistant Mine Superintendent at large base metal mine in South West Africa. Should be technical graduate and must have had at least 5 years varied mining experience in base metal mines. Same contract, etc. as above. F2163 (b).

Junior Metallurgist, degree in metallurgy, mining, or chemical engineering to perform control work and ore dressing research in a 5000-ton magnetic gravity flotation mill. Excellent opportunity for recent graduate to learn many phases of milling. Salary open. Location, Northeast. W2127.

Mining Engineer, young, with coal mining training. Excellent opportunities for well qualified engineer for growing coal mining organization. Location, Alabama. W2139.

Geologist with at least 5 years experience in exploratory work. Will take charge of exploration program in the field. Must speak Spanish and have had Latin American experience. Single status in beginning. No school facilities. Salary depends on experience. Mexico. F2221.


Preferred . . .
MIDWEST RADIANT CORP

BOOKS

French Bibliographical Digest: Science, Crystallography—Mineralogy, 2, No. 13, Series II, *The Cultural Division of the French Embassy,* 972 5th Ave., New York 21, N. Y., free, 102 pp., April 1955.—An excellent digest intended to make French scientific work better known in the U. S. Titles are translated and in most cases the publication is briefly described in English. This is a sequel to the geology volume, No. 11, Series II, which appeared in October 1954 and which is still available.

Geology of the Stone Mountain—Lithonia District, Georgia, by Leo Anthony Herrmann, *Georgia State Div. of Conservation, Dept. of Mines, Mining & Geology,* Atlanta, Ga., Bulletin 61, $4.00, 139 pp., 1954.—An investigation of one of Georgia's most important granite districts. Illustrated, maps in pocket.

Introduction to the Soils of Wisconsin, A General Scheme of Classification of the Principal Soils of Wisconsin, by Francis D. Hole and Gerhard B. Lee, Bulletin 79, Educational Series 10, 10¢, 48 pp., illustrated, 1955. Available from Secretary, Soils Dept., *University of Wisconsin,* 203 Soils Bldg., Madison 6,Wis.

Please Order These Publications from the Publishers

Map Showing United States Uranium Deposits, compiled by R. W. Schnabel, *U. S. Geological Survey,* MR 2, 50¢, 34x52 in., 80 miles: 1 in. Symbols of various shapes and colors show where principal types of uranium deposits are located—in sandstone or limestone, in phosphorite, in shale, in coal or lignite, or in veins. A distinction is also made between deposits being mined and those considered too low in grade to be mined under existing conditions, or from which uranium can be recovered only as a byproduct. The map is based on information from published and unpublished reports of the AEC, its contractors, and the USGS. Included are discoveries by private individuals, corporations, and Government agencies. Copies may be ordered by mail from the Geological Survey Centers at Washington 25, D. C., and Federal Center, Denver 2, Colo. Over-the-counter but *not* mail purchases may be made at: Room 1028 GSA Bldg., Washington, D. C.; 807 Post Office and Court House, Los Angeles; 724 Appraisers Bldg., San Francisco; 468 New Custom House, Denver; and 504 Federal Bldg., Salt Lake City.

Tables of Fluorescent and Radioactive Minerals, compiled 1947 by Robert L. Hershey, 2nd edition, revised 1955 by Ming-Shan Sun, *New Mexico Institute of Mining and Technology,* Campus Station, Socorro, N. M., Circular 15, free, 17 pp., mimeographed, 1955.

Mineral Resources of the Navajo Reservation in New Mexico (exclusive of uranium, coal, oil, gas, and water), by John Eliot Allen, *New Mexico Institute of Mining and Technology,* Campus Station, Socorro, N. M., Bulletin 44, $1.00, map sheet, 1955.—The investigation "indicated the presence and location of a number of rock and mineral deposits of present or potential economic value . . . Most of these deposits require further detailed sampling, testing, drilling, exploration, and marketing studies before their utility and value can be determined to the point where exploitation can be justified."

Technical Surveys, 338 Rahway Ave., Elizabeth, N. J., yearly subscription $35.00, six months $18.00, two years $67.00. Now in its tenth year, this weekly report on advances in technology covers developments in chemistry, metallurgy, electronics, building and air conditioning, food, plastics, textiles, medicine, aviation, fuels, paper, transportation, and other fields. Information is selected from newspapers, technical periodicals, press releases, house organs, trade journals, and other domestic and foreign publications. A sample copy is available without charge by writing the above address.

Mining Year Book 1955, compiled by Walter E. Skinner, *Walter E. Skinner*, 20, Copthall Ave., London, E. C. 2, England, $7.00 postfree, 864 pp., May 1955.—Complete and up-to-date information on 968 mining companies operating in all parts of the world. Particulars include directors, dates of incorporation, description of property, plant erected or in course of erection, capital, dividends, and financial position. Addresses are given for 1168 mining engineers and managers and the companies with which they are connected.

Who's Who in Commerce and Industry, *Marquis-Who's Who Inc.*, Marquis Publications Bldg., Chicago 11, Ill., $20.00, 1250 pp., 9th international edition, 1955.—Biographies-in-brief of 20,000 business executives key-indexed to more than 6000 leading firms. Numerical keys enable a user who wants to know the names of executives in a company to look up the company and follow the keys to the biographical section.

The Rotary Kiln, Its Performance Evaluation and Development, by Victor J. Azbe, *Azbe Corp.*, 8135 Forsythe Blvd., St. Louis 24, Mo., $3.50, 89 pp., 1954.—This material was presented before the National Lime Assn. in 1954. It contains 49 charts, diagrams, and drawings. Part I deals with current performances of rotary kilns, their deficiencies, and possible corrections. Part II discusses designs that lead toward attaining the highest kiln capacity and thermal efficiency.

The Non-Ferrous Metal Industry in Europe, *Organisation for European Economic Cooperation*, 2002 P St. N.W., Washington 6, D. C., $1.50, 160 pp.—A study by the Nonferrous Metals Committee, OEEC. This general report is supplemented by a series of studies by experts. Noting that 1954 showed an improvement in production and consumption, the committee stresses the influence of noncommercial factors, such as the U. S. stockpiling policy, which cannot fail to have repercussions in Europe.

Clays and Clay Technology, Proceedings of the First National Conference on Clays and Clay Technology, assembled and edited by Joseph A. Pask and Mort D. Turner, *California Div. of Mines*, Ferry Bldg., San Francisco 11, Calif., Bulletin 169, $4.50, 326 pp., 1955.—Most of the contributions in this book were papers given at the Clay Conference in Berkeley, Calif., in 1952. This series of 25 articles, written by technical experts, will serve as a basic reference volume and as a textbook for advanced students and workers in geology, mineralogy, soil science, agriculture, ceramics, engineering, and petroleum technology. Illustrated with photographs, diagrams, differential thermal analysis curves, and electronmicrographs.

Third Annual Conference on Soil Mechanics and Foundation Engineering, *University of Minnesota*, Center for Continuous Study, Minneapolis 14, Minn., free, 51 pp., illustrated.—The conference was held Apr. 7, 1955 at the university.

The Southwest Resources Handbook, *Southwest Research Institute*, 8500 Culebra Road, San Antonio, Texas. To be published Jan. 1, 1956. Subscription: first year $250.00, annual supplements $100.00. This source book will contain facts about the Southwest and its resources, presented in graphs and tables, interrelated by concise text. Agricultural, geographic, human, and mineral resources will be covered.

Mining Development in Asia and the Far East 1953-1954, Mineral Resources Development Series No. 4, *United Nations*, available from Columbia University Press, 2960 Broadway, New York 27, N. Y., 70¢, 83 pp., 18 maps, 1955.—Although the coal, gold, and manganese ore industries have met increasing difficulties, mineral production in Asia and the Far East has shown, in general, a substantial improvement.

Durability of Aggregates in Concrete Mixes (Final Report) by R. H. Picher, *Mines Branch, Dept. of Mines & Technical Surveys*, Ottawa Canada, Memorandum Series 129, 50¢ Can., 66 pp., 1954.

Jagged rocks, grinding gravel, severe cold and

Rugged Work and a hose to match!

U. S. 4810 Air Hose

Jagged rocks, grinding gravel, severe cold and sun checking, punishing impacts from heavy equipment—all these were faced *and licked* by the "U. S." engineers who designed U. S. 4810. Reason enough why it's become one of the most popular of all hose for mines, quarries, shipyards and general construction work.

Combining super adhesion, great strength, high resistance to cuts and abrasion, and extreme *flexibility*, U. S. 4810 is recommended for all pneumatic tools and air drills, for use *wherever* high working pressures, abrasion, and general abuse pose problems.

Service-packed, economical U. S. 4810 Air Hose is available from any of our 27 District Sales Offices, or by writing to the address below. *Whatever* your hose requirements, you'll find it pays to turn to "U. S." There's a job-engineered U. S. Hose for practically every purpose — an expert staff of "U. S." Engineers to assist you with your hose selection.

* tough, flexible tube of neoprene provides top oil resistance

* high-tenacity, tire-type cable rayon braids give tremendous carcass strength

* thick cover of cut-resistant natural rubber wards off damage from rocks, tools, and equipment

"U.S." Research perfects it..."U.S." Production builds it...U.S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes
Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

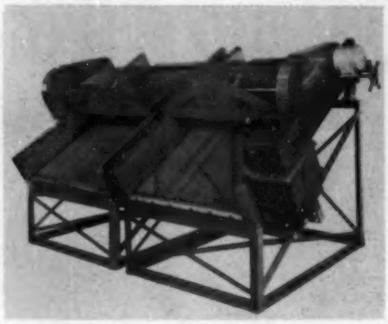
Manufacturers News

News Equipment Catalogs

• FILL OUT THE CARD FOR MORE INFORMATION •

Dual Heated Screens

The Deister Concentrator Co. has come up with a new design for pairs of Leahy heated screens. This Flex-Elex arrangement uses a single 20-kva heating transformer for savings in installation cost and for increased electrical efficiency. Bus bar installation is short, direct, and so placed that buses are not flexed. **Circle No. 1**

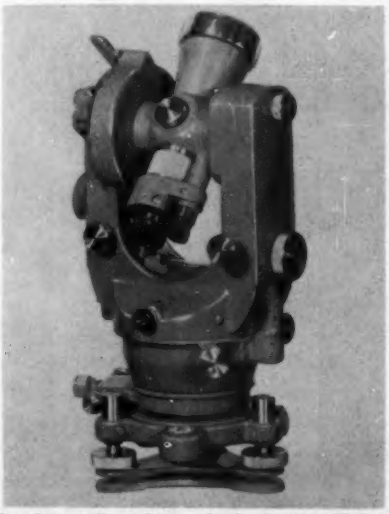


Coal Dryer

Dorr-Oliver Inc. announced the availability of the Dorrco FluoSolids system for heat drying of fine coal. Drying is accomplished without measurable oxidation, capacity per unit area is high, and efficiency is excellent, according to the manufacturer. A two-compartment reactor is the primary component of the system. **Circle No. 2**

Optical Repeating Transit

The *Wild Heerbrugg Instruments Inc.* model T-1 optical repeating transit offers direct reading to 20 sec and interpolation to 10 sec on both horizontal and vertical circles. Price of new model is $718.00 f.o.b. Port Washington, N. Y. The standard model, reading to 1 min and estimating to 6 sec, is now priced at $700.00, including case. **Circle No. 3**



Faster Grading

Hargus Markers speed grading and earthmoving with a line of easily read slip-on grade stake markers. Equipment operators can keep moving and make grade with every pass, according to the makers of these stakes. Markers are visible up to 1000 ft away and various types are used for grades in feet, tenths, or hundredths. **Circle No. 4**

Rope Belt Conveyor

A radical departure from the conventional style rigid structural frame belt conveyor is offered by *Goodman Mfg. Co.* The conveyor belt is carried on chain-linked idler rolls suspended between taut parallel wire ropes. The flexibility of the support eliminates shock from the idlers and eliminates idler impact from the belt. Advantages of the design is lengthened life for belt and other conveyor components. The rope belt conveyor conforms to uneven mine bottom and can be suspended over gullies and roads when used on surface. **Circle No. 5**

Wire Rope Inspection

Tyler & Co. Ltd. (London) has developed the Defectoscope to enable wire rope users to check cables in place. Already proved by use on the ropeways and cableways of Switzerland, and adopted by the British National Coal Board, the device shows up flaws, wear, and rust as well as marking the point of damage and its extent. Reduction in cross section of 0.1 pct or more is noted and recorded. **Circle No. 6**

Big Crawler

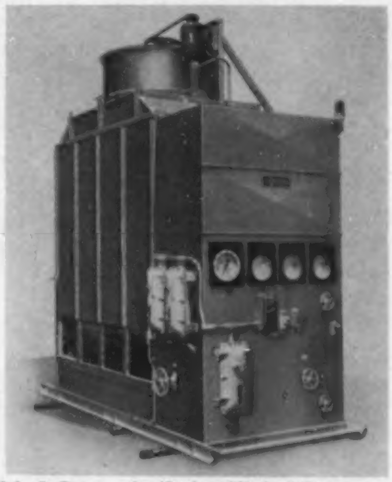
The expanding line of products from *Euclid Div.*, General Motors Corp. now includes the C-6 crawler, which is in effect a half section of the big TC-12 introduced last year. The C-6 has a single 194-hp engine and is designed for earthmoving, open pit mining, and related applications. **Circle No. 7**

Liquid Storage

Rock-Seal, an emulsion of neoprene and silicone rubbers, is being offered by *Storage & Sealing Corp.* for sealing underground excavations and concrete tanks to provide low cost storage for bulk liquids. The coating is chemically inert and highly resistant to a wide range of chemicals and oils. **Circle No. 8**

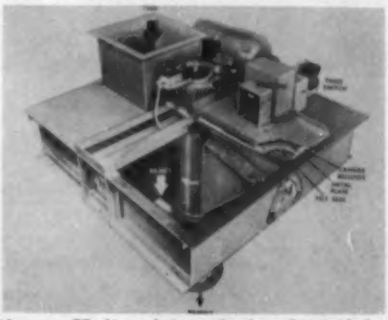
Ammonia Converter

The portable ammonia converter illustrated below is the largest of its kind. It was built for Nickel Processing Corp., Nicaro, Cuba, by *J. C. Carlile Corp.* High efficiency is claimed for portable unit. **Circle No. 9**



Automatic Sampler

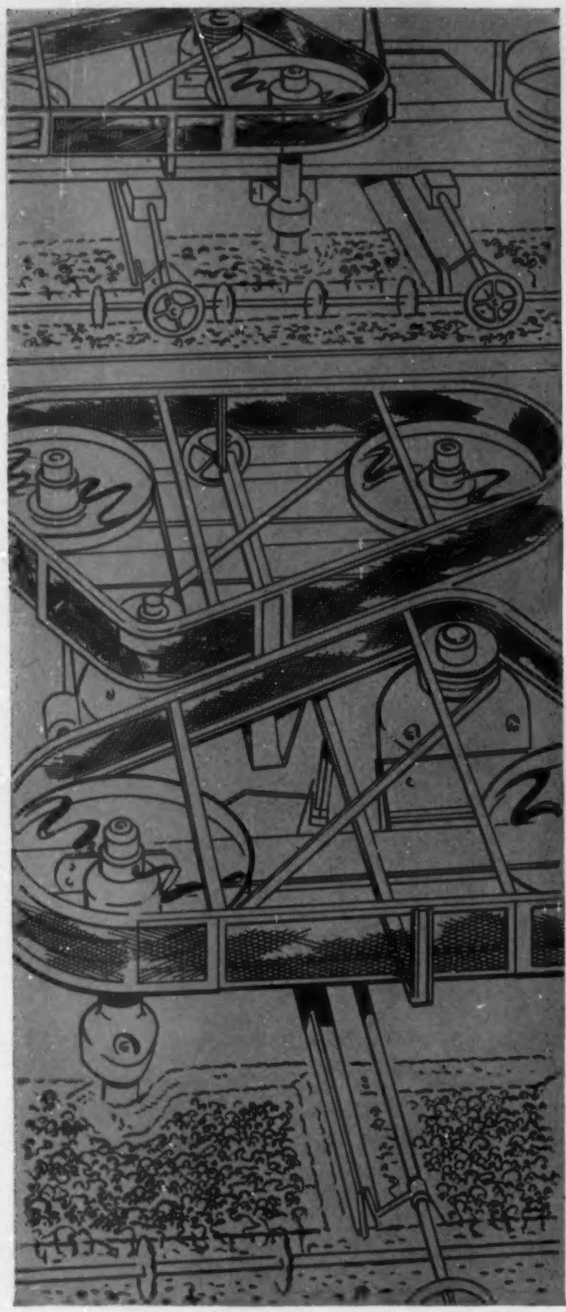
Denver Eqpt. Co. has completed an automatic Vezin-type dry sampler that promises to answer the dust problem at many sampling installations. Unit pictured is dust-tight machine for a cement plant. A unique feature is the solenoid controlled cover over the cutter opening. **Circle No. 10**

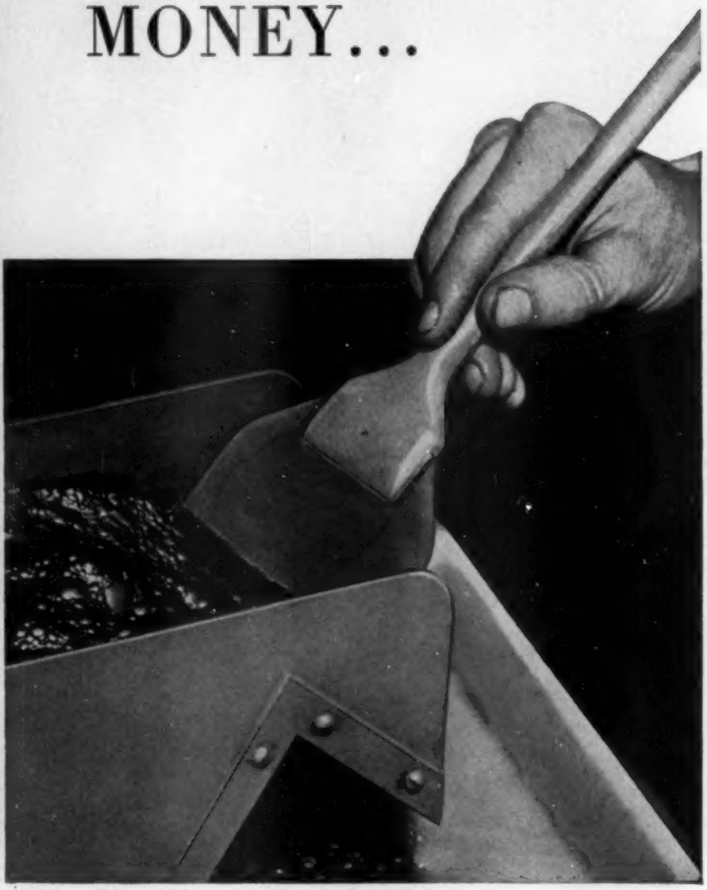


Dust Collection

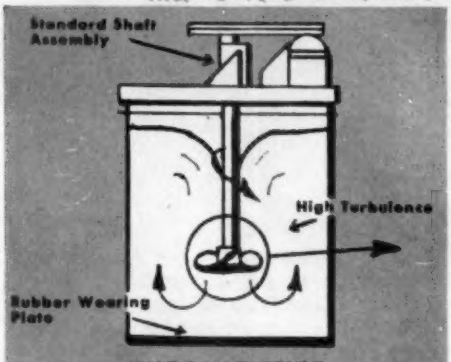
Power-driven dust collector and fractionator introduced by *Majac Inc.* utilizes rotating deflector plates and separator blades. Collection may be either wet or dry. **Circle No. 11**

(Continued on page 1000)





Here are the tools to help you solve your Agitation problems and *Increase Profits!*

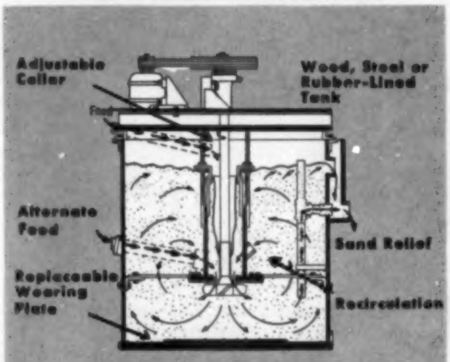


TURBINE TYPE AGITATOR

DENVER Agitators for mixing and leaching

(Copper, uranium, vanadium, lithium, cobalt, zinc)

Denver Agitators and Conditioners are the only machines that are flexible enough to be adapted to meet changing ore conditions. Heavy duty construction gives you dependable service 24 hours a day!

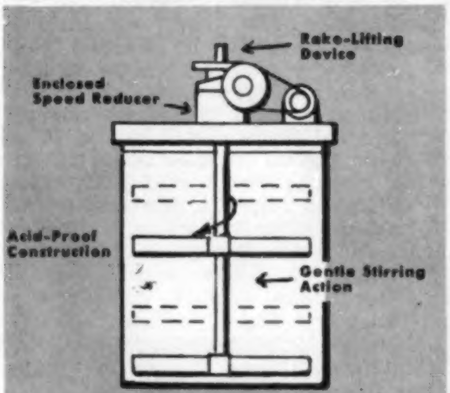


SUPER AGITATOR AND CONDITIONER

DENVER Agitators for flotation

(Barite, phosphate, fluorspar, iron, lead, zinc, copper feldspar)

The patented Denver standpipe gives you a flexible tool to change agitation and aeration to meet your exact requirements. These fool-proof machines will mechanically do your job—low maintenance.



STRAIGHT BLADE STIRRER

DENVER Agitators for precipitation

(Vanadium, lithium, uranium, copper)

This new machine was designed by DECO engineers especially to meet the needs for leaching operations in the Uranium industry—complete suspension of solids without excessive agitation. It is another example of how DECO engineers help their customers solve special jobs!

Our Bulletin A2-B4 describes these Denver Agitators in detail.

WHAT DELIVERY DO YOU NEED? INVESTIGATE NEW LOW PRICES!

"The firm that make its friends happier, healthier and wealthier"

DECO FLOTATION ENGINEERS — DENVER EQUIPMENT COMPANY 24 HOUR SERVICE

DENVER EQUIPMENT COMPANY

1400 SEVENTEENTH ST. CHerry 4-4466 DENVER 17, COLORADO

Denver • New York • Chicago • Salt Lake City • Toronto • Vancouver • Mexico D.F. • London • Johannesburg

Traxcavator

Advantages of integral tractor and shovel design have been incorporated in a new Traxcavator completed by *Caterpillar*. This model

955 utilizes a 1½-yd bucket and features excellent operator visibility and comfort. A 40° possible bucket tilt lowers cycle time and aids digging action. **Circle No. 12**

Slurry Valve

Already proved by two years' service on abrasive slurries at a large copper producer, the Krebs rubber slurry valve takes a new approach to the control problem. The units announced by *Equipment Engineers Inc.* utilize a massive molded rubber section actuated by hydraulic pressure for rupture-free positive action. **Circle No. 13**

News & Notes

Brunner & Lay, rock bit and drill steel manufacturers with main offices at Franklin Park, Ill., has opened a new plant at Asheville, N. C. . . *Hercules Powder Co.* is making a $2 million expansion of its Bacchus, Utah, plant . . . C. W. Marwedel, San Francisco industrial supply house, has become a subsidiary of *The Garrett Corp.* . . . *Dorr-Oliver Inc.* has acquired marketing rights to the Merrill-Crowe cyanide precipitation and regeneration processes. Dorr-Oliver also announced that its Westport, Conn., laboratories are now fully equipped to handle all types of uranium extraction studies . . . *Allis-Chalmers Mfg.* Co. has established six operating divisions, with three in the Tractor Group, formerly the Tractor Div., and three in the Industries Group, formerly the General Machinery Div. . . . *Climax Molybdenum Co.* has chosen *Whitehead Metal Products Co.* to distribute Climax products in the East. . . . *Clark Eqpt. Co.* will build a plant in the San Francisco Bay area . . . . *Hewitt-Robins Inc.* has received a contract to install a series of conveyors and related units at the new Tuba City, Ariz., uranium plant . . . . *Hardinge Co.* will exhibit its Disc Roll mill at the Chemical Industries Exposition, Philadelphia, December 5 to 9 . . . . Byron Jackson, pioneer pump builder became the *Byron Jackson Div., Borg-Warner Corp.* effective September 1 . . . . *Dravo Corp.* has initiated a $400,000 building program for centralized research facilities at Pittsburgh.

(21) ROTARY DRILLS: Want to lower drilling costs? Full details are available from *Davey Compressor Co.* One of Davey's six models is the M-8MA rated at 1000 ft. Normal performance with a 6-in. drill bit is 150 to 600 ft in sedimentary rock formation with air. With a 9-in. drill bit, it will drill to 1000 ft plus. Drill operates with either air compressor or mud pump.

(22) EXPLOSIVES: Coal strip miners are cutting explosive costs from 40 to 60 pct by making their own explosives for overburden shooting. Available from *Spencer Chemical Co.* is information on the new Akremite method, which uses Spencer commercial grade ammonium nitrate as its main ingredient.

(23) NEOPRENE: Among the articles in the latest issue of "Neoprene Notebook" from *Du Pont's* Elastomers Div. is one on skin-diving geologists and another on continuous cooling and solidifying of molten sulphur.

(24) DUST COLLECTOR: Used to collect dust, powders, and fumes in industrial plants, the *Torit* cyclone-type dust collector recirculates filtered air back into the room, thus preventing heat loss during cold weather. After-filtering mechanism contains six throw-away filters made of glass insulation wool.

(25) pH METER: Model 125 shown in bulletin 118 from *Photovolt Corp.* is powered by three ordinary radio batteries that last 2000 hr. Also available is a stabilized power unit for alternate operation from AC lines without batteries.

(26) MATERIALS HANDLING: The *Kwik-Mix Co.* catalog on the Moto-Bug shows how this material handling unit is adaptable for coal yards, foundries, concrete products, and many other applications. Hopper, platform, and forklift attachments are easily interchanged on a standard chassis.

(27) MAGNETIC SEPARATION: *Ohio Electric Mfg. Co.* has a 4-page bulletin on rectangular electromagnetic separators designed for suspension over the head pulley or in a horizontal position over a conveyor belt. Arrangement of poles provides a practically uniform high-Gauss field across the belt, resulting in effective removal of tramp iron.

(28) DRILLS: The 40-page catalog from *Acker Drill Co.* is indexed and divided into seven sections for easy reference. It contains a complete and up-to-date listing of all drilling tools and supplies for soil sampling, mineral prospecting, and core drilling.

(29) CONVEYOR BELTING: Cartoons catch the eye in *Hewitt-Robins'* wall chart on the proper selection

and maintenance of conveyor belting. The 23x33-in. chart has excellent advice on belt storage, correct design of loading chutes, belt repair, and other important aspects of maintenance. Also listed are types of belts for various uses: mining, metal processing, and coal handling.

(30) BURN KIT: Made by the *Mine Safety Appliances Co.*, the MSA Foille burn kit has four 10-oz Aerosol sprays and type D first aid dressings and accessories. Just remove the cap, aim, and press the button and the injured area is sprayed in seconds. Foille controls pain, mitigates shock, and helps preserve tissues. Its detergent action often eliminates the necessity of scrubbing grease-stained dirty wounds.

Free Literature

(31) AIR LINE LUBRICATORS: More than 50 pct of all compressed air tool failures are due to lack of proper lubrication. *Ingersoll-Rand's* form 4169 tells how to prevent this costly damage. Lubricators shown are made in sizes for use with the smallest hand-held tools to the largest quarry-type drills.

(32) PROSPECTING: Bulletin from *Moran Instrument Corp.* covers a complete motor driven scintillation counter logging unit. Instrument with 1500 ft of cable weighs less than 160 lb. It can be mounted on a drill rig or supplied with portable mounting base for pickup truck, jeep, or station wagon.

(33) RUBBER SLURRY VALVES: Four-page brochure from *Equipment Engineers Inc.* illustrates why the Krebs rubber slurry valve was developed, how it is built and how it works. Additional information lists sizes and prices of valve only and valve complete with hydraulic control unit.

(34) CAT ATTACHMENTS: Owners and operators of *Caterpillar* tractors and motor graders will be interested in new attachments shown in an 8-page booklet. Included are hydraulic steering boosters for motor graders, cast steel final drive cases, rolled steel crankcase guards, and electric starting systems.

(35) U PROSPECTING: *Radiac Co. Inc.* has a series of bulletins on atomic and geophysical prospecting instruments with models to suit various applications and budgets. Included is a uranium ore price chart and information on ultraviolet Mineralights, uranium test kit, and a uranium assay kit for on-the-spot identification and radioassay.

MAIL THIS CARD

for more information on items described in Manufacturers News and for bulletins and catalogs listed in the Free Literature section.

Mining Engineering **29 West 39th St.** **New York 18, N. Y.**

Not good after Feb. 15, 1956—if mailed in U. S. or Canada.

Please send me { More Information ☐ / Price Data ☐ / Free Literature ☐ } on items circled.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	Students should write direct to manufacturer.						

Name____________________ Title__________

Company______________________________

Street______________________________

City and Zone____________________ State__________

(36) CABLES: *Anaconda Wire & Cable Co.* has a 4-page folder on Powerduct cables for flexible bus-drop power distribution. The folder gives complete information and tabular data on the company's Duracord and Densheath-type cables, as well as directions for normal installation with overhead bus-duct.

(37) INSTRUMENTATION: Bulletin 100-D is an index of literature from the Industrial Div., *Minneapolis-Honeywell Regulator Co.* It covers catalogs, bulletins, specification and data sheets, and articles from "Instrumentation" magazine.

(38) PULLEYS & SEPARATORS: Bulletin 303-C from *Stearns Magnetic Co.* deals with electro-magnetic pulleys and pulley separators. Contents include: operation principles, approximate weights of materials, selection factors and procedure, and application fields.

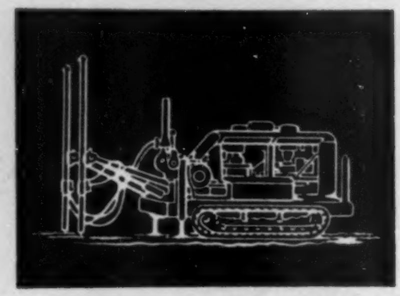
(39) STRIP MINING: "The Challenge," an 8-page bulletin from *Caterpillar Tractor Co.*, shows how successful strip miners make their machines pay. The all-important reason is equipment application, planned to keep costs down.

(40) CRAWLER TRACTOR: Form MS-662 from *Allis-Chalmers Mfg. Co.* is a pictorial presentation of the design, engineering, and operating advancements that make the HD-16 crawler tractor "outstanding in its weight and hp classification." Also included are specifications, information on matched attachments, accessories, and operator comfort.

(41) GAMMA GUN: Made by *Universal Atomics Corp.*, the UCA 511 weighs 5 lb and can be used on the ground or in the air. Completely self-contained, it requires no external power supply or installation. It is said to be the only self-contained, hand-portable scintillation counter giving 500,000 counts per min—300 times more sensitive than a single Geiger tube.

(42) WET DUST COLLECTOR: *Dust Suppression & Eng. Co* has a bulletin on the type "W" air tumbler, which consists of a stationary screw with a horizontal pear-shaped barrel. Dust is separated from the air by centrifugal action; then wetted and trapped.

(43) HYDRAULIC BOOMS: *Ingersoll-Rand* has a bulletin on Hydra-Boom applications and their advantages over other drills in construction and mining. Dimensioned



coverage diagrams show the area that can be covered by each boom, both vertically and horizontally. Information on special Jumbo mountings includes a four-boom, self-propelled machine for drilling a face 40 ft high underground.

(44) ELECTRIC CAP LAMP: Bulletin M-19 from *Mine Safety Appliances* Co. is on the Edison R-4 electric cap lamp, which carries USBM approval No. 29. Requiring less handling, less maintenance, the R-4 has a headpiece adaptable as a long-range spotlight or with matte reflector as a floodlight for close work. Battery withstands long idle periods or other forms of abuse.

(45) NEW SCREEN: *Allis-Chalmers'* Aero-Vibe, utilizing a simplified two-bearing design with counterweight wheels, handles feed up to 4 in., coal to 6 in. Separations can be made from 1½ in. to 35 mesh. This new vibrating screen is available in suspended or floor-mounted models, with one, two or three decks in sizes 3x6 to 4x10 ft.

(46) COPPER-BASE ALLOYS: "Metallurgical Developments in Copper Base Alloys" from *International Nickel Co.* calls particular attention to corrosion resistance and strength of actively developed manganese, aluminum bronzes, and cupronickels.

(47) LOADING PROBLEMS: Four-page folder from *Magnesium Co. of America* contains solutions to 13 difficult dock and yard loading problems. Line drawings illustrate the problem, and photographs show how they were solved by Magcoa magnesium dockboard or yard ramp.

(48) 3-CU YD SHOVEL: *Bucyrus-Erie* has a 16-page bulletin on the 71-B shovel, which is readily convertible to dragline, clamshell, or lifting crane. Powered by a 6-cyl GM diesel, it is equipped with Torcon torque converter or conventional drive.

(49) HOW STEEL IS MADE: Colored photographs and short captions tell the story in the brochure from *Rotary Electric Steel Co.* The complete facilities of this modern steel mill are designed for the production of alloy, stainless, and carbon steel in slab, billet, and bar forms.

(50) WALKING DRAGLINES: Single deck walking dragline machines shown in catalog from *Page Engineering Co.* are available in capacities from 5 to 15 cu yd. They are ideal for coal stripping, levee and drainage work, and for the general contractor.

(51) TEMPERATURES: *Tempil Corp.* has an 8-page booklet, "How Temperatures Are Measured." Some of the topics covered are: the history of temperature scales, temperature measurement by chemical signal, by color, and by thermometers and pyrometers.

(52) RUBBER PRODUCTS: Catalog digest from Industrial Rubber Div., *Thermoid Co.*, contains specifications for 68 different rubber hose. Also shown are conveyor and elevator belts, transmission and V-belts, sheet packing, chute lining, and friction materials.

(53) MACHINE CABS: Product illustration sheets from *Crenlo Inc.* show model 1105 AM winterized enclosure and tailored cabs for Caterpillar, John Deere, and International Harvester tractors, Allis-Chalmers four-wheel prime movers, and a Whiting trackmobile.

(54) SURFACTANTS: The Chemical Div., *Armour & Co.*, has a booklet on ethylene oxide derivatives of fatty acids, fatty amines, and fatty amides. These surfactants (surface active agents) are proving useful as emulsifiers, wetting agents, detergents, intermediates, and antistatic agents.

FIRST CLASS
PERMIT No. 6433
Sec. 34.9 P.L.&R.
New York, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c.—POSTAGE WILL BE PAID BY—

MINING ENGINEERING

29 WEST 39th STREET

NEW YORK 18, N. Y.

Two Unusual Mica Plants

Synthetic Mica Corp., subsidiary of Mycalex Corp. of America, recently opened a synthetic mica plant in New Jersey. Operation is first in world designed solely for production of synthetic material. . . . International Minerals & Chemical Corp. has begun construction on a plant at Greeneville, Tenn., for reclaiming mica in silt accumulated behind the Davy Crockett Dam. Product will find use in roofing, paint, and rubber industries.

Alumina From Northwest Clays

Anaconda Aluminum Co., the nation's fourth primary aluminum producer, believes it has a process to make alumina available from clays of the Pacific Northwest. Company has acquired holdings of clay properties in the region and hopes to have the beneficiation process in use by 1957.

National Lead Ups Titanium Reserves

A new discovery near National Lead Co.'s plant at Tahawus, N. Y., has 50 million tons of proved titanium ore and there are hopes of perhaps 100 million tons of reserves being developed. Discoveries in Norway near National's present operations in that country are indicated to have 100 million tons of ore, and perhaps 300 million tons of reserves may eventually be proved. The third addition to reserves came through acquisition of a 6800-acre tract in Florida. Tract adjoins the Trail Ridge deposits and some 5 million tons of ilmenite are expected to be produced from the Florida purchase.

Copper in the News

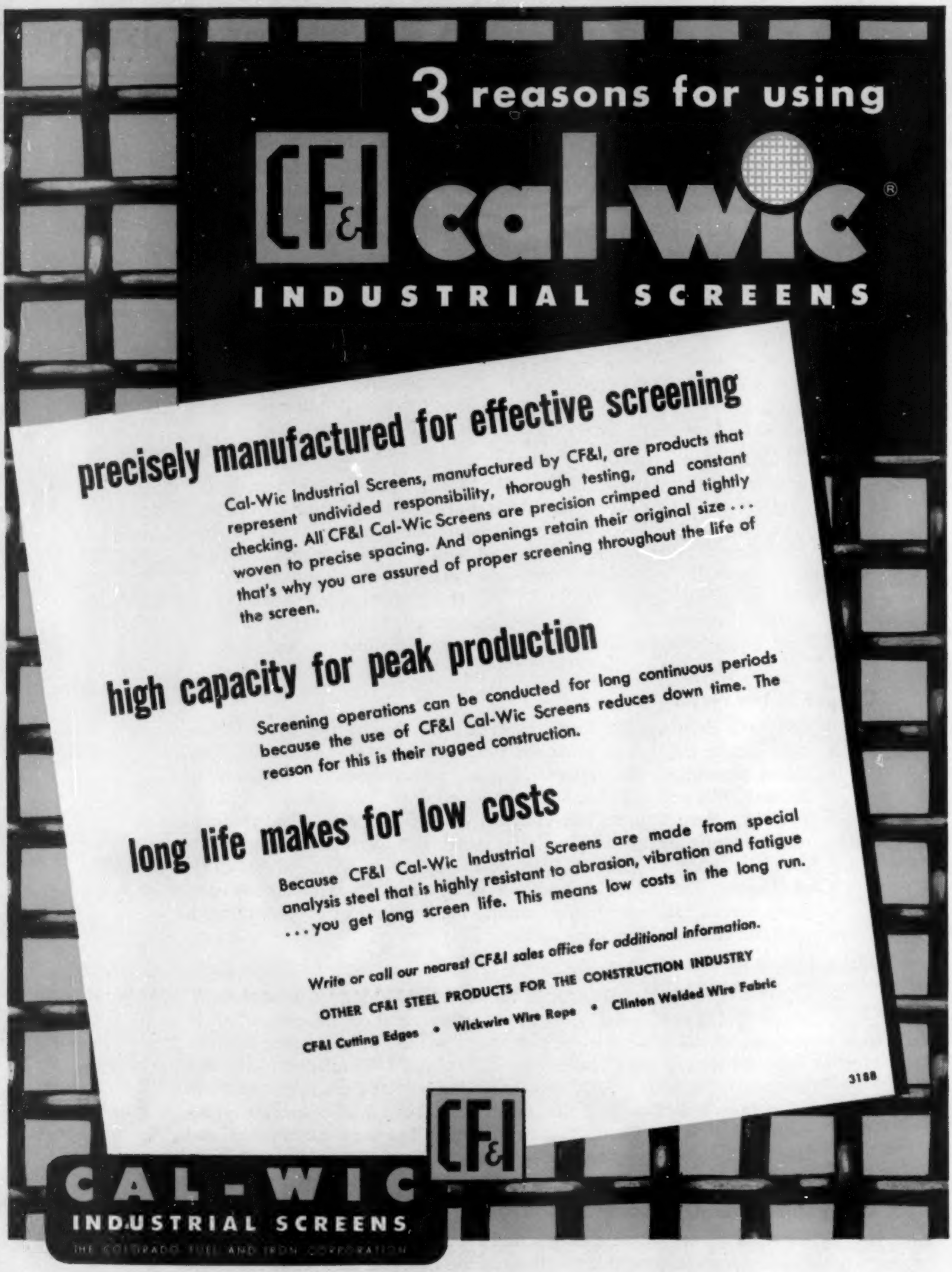
Southern Peru Copper Corp., currently developing the large Toquepala copper deposit in southern Peru, has elected Edward M. Tittmann president. Mr. Tittmann was recently general manager of Asarco's Western dept. . . . Cerro de Pasco Corp., which holds 16 pct of Southern Peru Copper, has been active in South American ventures other than its big copper properties there. But Cerro is making its latest move in the U. S. and has agreed to buy Circle Wire & Cable Corp. of Maspeth, L. I. This $20¼ million purchase would diversify the company, already an active miner, smelter, and refiner of copper, through addition of a manufacturing unit.

More Iron Ore

Operation of the first section of the Reserve Mining Co.'s huge E. W. Davis Works in Minnesota began in October, and construction of all 12 sections of the plant will be completed within three or four months. Total capacity of the 12 sections will be about 3.375 million LT of iron ore pellets per year . . . . Quebec-Labrador area iron ore operations will ship about 7 million tons this year, well above figures originally announced. Iron Ore Co. of Canada will move 6 of the 7 million tons, and the two concession companies—Hollinger North Shore and Labrador Mining & Exploration—will share the remaining million tons of output.

Companies Shift Uptown in New York

New York real estate changes find several major mining companies moving from long-settled locations in the financial district at the tip of Manhattan to midtown points. Shifts include those of Cerro de Pasco Corp., Newmont Mining Corp., Phelps Dodge Corp., and San Manuel Copper Corp. all moving to a new building at 300 Park Ave., New York 22.



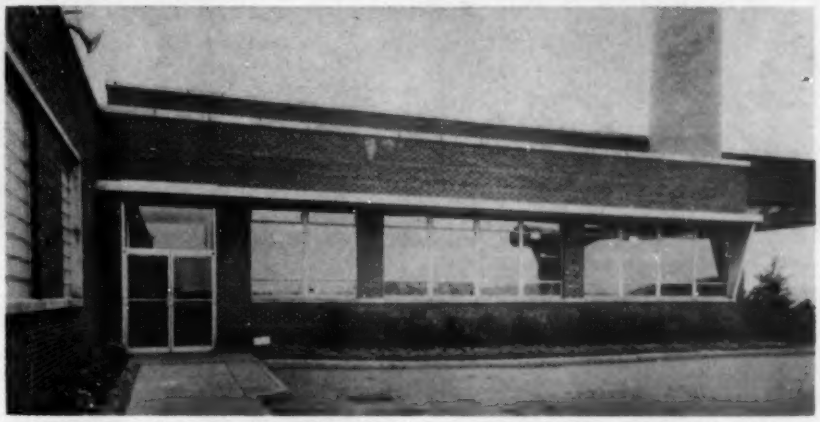
Albuquerque • Amarillo • Billings • Boise • Butte • Casper • Denver • El Paso • Ft. Worth • Houston • Lincoln (Neb.) • Los Angeles
Oakland • Oklahoma City • Phoenix • Portland • Pueblo • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane • Wichita
Canadian Representatives at: Calgary • Edmonton • Montreal • Vancouver

CCI Safety Program Calls For Ample Training, Good Equipment

A soundly conceived, well executed safety program is helping to reduce risks involved in fire fighting and mine rescue work at The Cleveland-Cliffs Iron Co. mines, Negaunee, Mich.

Heart of the CCI program is regularly scheduled twice-a-year training for approximately 200 employes and an adequate supply of various types of safety equipment.

The training program, supervised by the CCI director of safety, is based on learning the correct use of safety devices offering protection against hazardous conditions that might be encountered in emergency operations. Classes are held in the company's modern mine rescue station.



Good illumination eases the problem of "classroom fatigue" during safety instructions by engineers of CCI's mine rescue station at Negaunee, Mich.

Classes in safety and the correct use of safety equipment in fire fighting and mine rescue operations are held twice a year by safety engineers at CCI's mine rescue station at Negaunee. Instruction is conducted in this modern classroom.

Proper use of the company's safety equipment has helped solve the underground fire fighting problem by providing protection for members of the mine rescue teams. The company maintains a total of 84 units for respiratory protection manufactured by Mine Safety Appliances Co.

Each mine is equipped with instruments to detect carbon monoxide and other poisonous gases, vapors, and smokes. Colorimetric testers are used to determine the carbon monoxide concentration and Flame Safety Lamps indicate the presence of methane gas, natural gas, or oxygen deficiencies in the air. Rescue equipment to protect the men includes McCaa 2-hr oxygen breathing apparatus and Chemox oxygen breathing apparatus. The Chemox unit generates its own oxygen to provide complete protection for 45 min against concentrations of toxic gases and oxygen deficiency.

Monthly inspections of the equipment by safety engineers assures a constant state of preparedness and keeps equipment replacement costs at a minimum.

Smoke tunnel at the mine rescue station of The Cleveland-Cliffs Iron Co., Negaunee, Mich., serves as a practical laboratory for twice-a-year indoctrination in the correct operation of safety equipment used in fire fighting and mine rescue work. Respiratory and detection equipment shown was manufactured by Mine Safety Appliances Co.

Danish Enterprise Opens Lead Mine in Greenland

Latitude 72°N —

Average Temperature 16°F

Danish miners used lightweight airleg drills in opening up the lead-zinc deposits at Mesters Vig.

Greenland's arctic north, hitherto inhabited only by hunters and a few weather observers, is witnessing development of a lead-zinc property. Northern Mining Co. Ltd., a Danish firm with Swedish and Canadian participation, is tackling the job of opening the area for Greenland's second major mining venture. For almost a century the unique deposits at Ivigtut have been the world's source of cryolite, but the new property will bring Greenland into the ranks of nonferrous metals producers.

The discovery stems from observations by Lauge Koch while he was returning in 1948 from an expedition to the East Greenland mountains. His report of traces of lead minerals led to further surveys and a study by the Danish Government.

Mine development called upon both dog sled and modern tractor for on-the-ground transportation.

The deposit proved to be galena and sphalerite mineralization in a quartz vein, and by 1952 enough data had been assembled to warrant formation of Northern Mining Co. Ltd. to undertake the exploration and development of the orebody.

Most serious of the problems facing the developers of the deposits at Mesters Vig were climatic. At 72°N latitude the average temperature is 16°F, and only in the warmest part of the summer do temperatures rise above freezing. Snowfall reaches as much as 15 ft, and except for brief periods in the summer,

Bringing supplies in by sea is possible only a few weeks a year. Massive ice blockades the whole eastern coastline of the subcontinent for the rest of the year.

Radio helps defeat isolation of mine site in northern Greenland.

shipping is barred from the coast by great masses of ice. In some years the shipping season is only six weeks long.

Despite these obstacles, matched at few mines, an airstrip has been carved out, buildings have been erected, crews of men brought in, and extensive development work has been carried out. So far more than 18,000 ft of diamond drilling and more than 6000 ft of tunneling have been completed.

Access to the operations is provided by an 8-mile road from King Oscar Fiord to the mine, which is at 1000-ft elevation. But without its airstrip Mesters Vig would be cut off from the outside world for more than ten months of the year by the ice along the coast. Even in the worst months of the winter the airstrip 6 miles away has provided a means of bringing in supplies, parts, mail, and provisions as well as making it easy to change personnel.

Treatment Plant

Present schedules call for start of mining and milling in the spring of 1956. For two reasons, the flotation plant will be installed inside a mountain—to save materials and to take advantage of natural air conditioning. Some 250 or 300 ft inside the mountain there will be no frost, and heat from the plant machinery will keep the temperature at a comfortable level.

Shipping also presents difficulties, since the estimated 20,000-ton annual production of flotation concentrates will have to be moved out within a six to eight-week season in most years. Some summers have longer shipping periods.

Looking to the future, a close search is being made of other parts of northeast Greenland where deposits are geologically possible. At Mesters Vig it is estimated that present known reserves are adequate for six to seven years of production at the present pace.

The village at Mesters Vig was built with well insulated wooden houses. Unusual for a mining camp is the village's central oil-fired heating plant. Water supply comes through electrically heated pipes from a nearby river. A power station, laboratory, hospital, and engineering shop are included among the structures. Size of crew varied from 50 to 150 during the four-year development period.

Kaiser Steel Adds to Limestone Reserves New Source Near Fontana, Calif., Mill

Kaiser Steel Corp. announced purchase of a large undeveloped limestone deposit in Southern California from Allen S. Vinnell and Clair W. Dunton. The price was in excess of $1 million.

The 10-sq mile area of mining claims, known as the Cushenbury deposit, is in San Bernardino County, near Lucerne Valley, about 30 miles southeast of Victorville, Calif.

"The addition of this limestone deposit to Kaiser Steel's raw materials reserves means that Kaiser Steel will be self-sufficient in the three basic materials—iron ore, coking coal, and limestone—used in making steel," J. L. Ashby, company vice president, said. "Both in relation to anticipated further substantial growth, as well as present requirements, Kaiser Steel is in one of the strongest positions of any steel company in the U. S. in its supply of raw materials. This important new source of limestone, just 75 miles from our steel mill at Fontana, is another convincing demonstration of the ability of Western resources to fill Western needs."

The deposit will also be the source of limestone for the new cement plant to be built by the Permanente Cement Co. at the same location.

Cement Plant is Also Planned

Kaiser Steel is negotiating a long-term pact with Permanente Cement calling for the latter company to build the facilities for mining and crushing of the stone and to operate such facilities for the joint account of the two companies. The arrangement will make for production economies because of a single mining operation and because the cement plant can use advantageously the waste limestone resulting from the production of the grade of stone required by the steel plant.

The Santa Fe RR will construct a 30-mile spur from Cushenbury to connect with its main line at Hesperia, Calif. Development of the mine is under way, although it will be about a year before all facilities are installed to permit the full-scale mining and shipping of limestone.

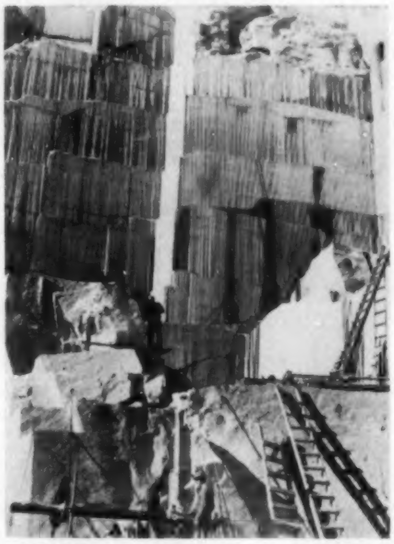
Encouraging Report On Safety Campaign

During the first six months of the Falls of Ground safety campaign all mines averaged 6.6 reportable injuries from falls of ground per million man-hr worked, or 27 pct less than for the base period 1954, 1953, and 1952. If participants had controlled injuries from falls of ground during these years as effectively as they did during the first six months of 1955, approximately 600 men would not have been injured or killed. It appears that special attention to this major hazard in the future will pay big dividends.

Experience with injuries from falls of ground improved in each of the major mining areas in the U. S. and Canada, with one exception. Mines in Idaho and in the eastern area of New York, Pennsylvania, Ohio, Virginia, and New Jersey achieved the largest average reductions in the frequency of injuries, 41 pct. Decreases in other areas ranged downward to 7 pct. U. S. mines, on the whole, averaged 6.3 injuries per million man-hr worked during the first six months of the campaign, or 19 pct less than the average for the three preceding years.

Vermont Quarry Tests Integral Steel

Rock of Ages quarry on Millstone Hill, Barre, Vt., largest granite quarry in the world, has recently speeded up drilling operations and cut production costs by converting to integral drill steel. Previously conventional carbon rods and detachable bits were in use. Exhaustive tests with integral steel over a six-month period showed a 20 pct reduction in drilling time and more than one third saving in steel and bit purchase and maintenance costs, according to the company.



Millstone Hill quarry. Man at top is plug holing. Below, channel bar rig used in deep holing. Vertical flutings show results of channel drilling.

Millstone Hill quarry has a unique granite formation—gigantic, irregular boulders instead of the usual parallel strata. The material is denser in grain, heavier (200 lb per cu ft), and costlier and more difficult to work than in most granite quarries.

Rock of Ages for several years has been using channel drilling and lift holing to free huge blocks from the quarry bed. For easier handling these blocks are then segmented by vertical deep holing across the grain of the granite, followed by shallow plug holing. After each of the later penetrations wedges are tapped manually into the drillholes to complete the splits.

Since only the best of the granite crop is suitable for working into top-quality dimensional stone—85 pct of all the rock quarried here ends up on the grout pile—precision drilling must be employed to carve out flawless units. After much trial and error it was found that deep holing gave the best results and the company reports it has substantially increased output of usable raw material.

Until December 1954 deep hole drillers at the Millstone Hill quarry had been using traditional equipment—varying lengths of steel rods with carbide-tipped detachable bits for a cutting edge. In order to deep-hole a block 15 ft deep, the driller started with a 6-ft rod mounted in a rock drill on a channel bar, then progressively replaced it with an 8, a 12, and finally a 16-ft rod to hole out. In approaching each of these levels one or more bits might be lost in the hole, which automatically slowed up penetration and granite production.

Integral Steel Test

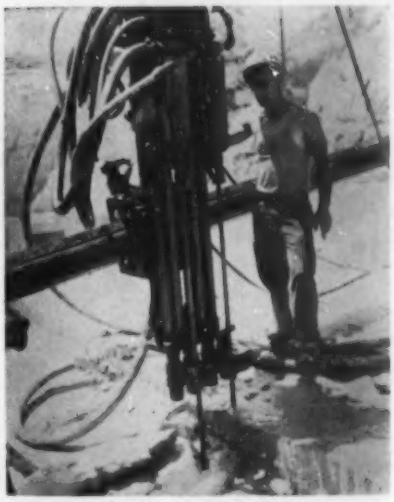
Then Clyde Belanger, production manager of the quarry, started an experiment in deep holing, using a TM-300 rock drill at 85 psi that was equipped with Sandvik Coromant drill steel. Equipment was supplied by Copco Eastern Ltd., with both rod and 1 5/16-in. tungsten carbide bit incorporated in one piece.

In the first experimental run the crew using integral steel drilled an aggregate of 20,175 ft in multiple deep holes, using a total of 53 combination rod-and-bit units for an average of 381 ft per drill steel. In comparison, carbon rods and detachable bits had averaged 448 ft per bit and 50 ft per rod, based on extensive footage records.

Although the integral steel showed an advantage of 20 pct in drilling speed, its rival bit apparently had turned in a better performance footage-wise.

Costs Tell the Story

Then cost accountants figured the respective operational costs for each method, and these computations told an entirely different story. Drilling 20,175 ft with detachable bits had cost $1,316.10, or $0.065 per ft, while the bill for Coromant steel drilling was only $856.79 at $0.042 per ft—a saving of 33.68 pct. Both calculations included the initial outlay for drill equipment, plus maintenance costs.



Deep holing with Sandvik Coromant integral steels at Millstone Hill quarry.

Further analysis revealed that integral steel saved 20 pct time, since it required no rethreading or reshanking. In man-hours and labor costs the integral steel effected still more savings, 20 pct in each category.

As a consequence of the trial runs, and others conducted later with similar results, Rock of Ages is now using integral drill steels in all deep-holing operations at Millstone Hill and has also converted to this type of steel for both plug and lift holing. Using Sandvik Coromant plug steel in an Atlas Copco rock drill, three drillers now turn out the work that formerly required six.

Plug holing in cutting yard at Millstone Hill quarry, using Atlas Copco rock drill and Sandvik Coromant plug steel.

Technical Team

In the Bunker Hill & Sullivan operation, a 48-in. *Hydrocone* crusher preceded by an Allis-Chalmers rod deck screen produces a minus ¾-in. feed for the 9 x 12 Allis-Chalmers dry grinding peripheral discharge rod mill which delivers a minus 10 mesh product for pelletizing.

Low-Head and Hydrocone are Allis-Chalmers trademarks.

ALLIS-CHALMERS
Equipment for the Mining and Rock Products Industries

A-4402

Crushers — all types

Vibrating Screens — all types — Grinding Mills — all types

Kilns — Coolers — Washers — Dryers — Smelting Equipment

CHALMERS

A-C ALLIS-CHALMERS

For complete information, call your nearest A-C district office or write Allis-Chalmers, Milwaukee 1, Wis.

FUSION and confusion came out of the Geneva Atoms for Peace conference—that and an amazing amount of solid information. Many of the press reports leaped on the mention of fusion (atomic that is) and threw that possible development and several other ideas out of all proportion to their immediate importance. Hence the confusion.

The confusion for a time spread to usually level headed members of the financial circles. So much so, that Floyd Odlum of Atlas Corp., which has a $15 million-strong interest in uranium, felt it necessary to send out a stockholders letter conveying his views based on attendance at the meeting. His message in brief was that nothing was revealed at the conference that appeared to him to change the relative importance of uranium in the development of atomic energy. He backed up his words by revealing various further expansions by Atlas in the uranium field.

One leading figure who formerly held a major post in the reactor development program put it this way: Atomic energy is here to stay—and uranium will play the major role as fuel source in the immediate period if not for many, many years to come.

Confusion in reading the press reports from Geneva arose from a simple failure by some reporters to differentiate clearly between scientific speculation, laboratory development, and engineering fact. The time spread between these stages in the development of something as complex as nuclear application is great. Results at the investors' level from some of the scientists' speculations might be 10 to 20 years away even if the "breakthrough" to a workable concept occurred today.

AEC Chairman Strauss made this point clear when he said: "It cannot be stressed too strongly that, based on what we now know, we are far from a solution of the problems of the controlled fusion reaction. Our work is in the research stage . . . I am convinced that it will come about, but I can't reduce my optimism to a number of years . . . Twenty years seems a fair guess. It won't astonish me if it comes sooner or if it takes longer." And what he is talking about here is an idea, such as the one that made the hydrogen bomb possible.

◆◆◆◆◆◆

STILL another facet of the atomic energy program has been the question of its impact upon power costs. In this regard the proponents of coal have some major points to make. The effect of atomic energy upon power costs was likened by one coal operator to the effect that changing from water to antifreeze in the radiator would have upon an automobile's operating costs. This may be an extreme view, but figures provided by the National Coal Assn. indicate that the idea has merit.

Electricity generated by coal is "a very inexpensive handservant that is always on call," Tom Pickett, executive vice president of the National Coal Assn., said recently regarding the Federal Government's attempt to develop the atom as a "cheap" source of electric power.

Fuel accounts for only 16 pct of the cost involved in bringing electricity to the consumer, Mr. Pickett explained; consequently a $6 electric bill could not be reduced by more than $1 "even if research should reveal a way to generate electricity through a self-perpetuating fuel."

Mr. Pickett's statement was in reply to a question on reports that the atom will eventually become an important source of electric power production. He said:

"I submit that coal is already bringing us cheap electric power. I have checked my own light bills, and I have seen the bills of some of my neighbors who have their television sets on from early morning until midnight, and who have electric washing machines and dryers, electric lawnmowers, and almost every type of contraption you can think of for doing work in the kitchen.

"Their bills may come to $6 or $7 a month. When they are informed that fuel costs account for less than 16 pct of the total costs involved in generating that power and in bringing it to their homes, then they begin to understand what an outstanding job the coal and electric ultilities companies have accomplished in making these rates possible."

Mr. Pickett said that increased efficiency in coal production and combustion have reduced generating costs in modern steam plants to less than 3 mills per kilowatt hr, in contrast to the "7-mill electricity" which atomic scientists hope will eventually materialize.

◆◆◆◆◆◆

THERE is a strong tide in the mineral industry toward making an active public relations program an integral part of company planning. Those companies with such programs are strengthening them and increasing their staffs, those without are turning to public relations counselors or building new departments. Which all leads to the question: What is public relations?

Writing in the *General Electric Review*, Kenneth G. Patrick of GE's Public Relations Services puts it this way: "We can define public relations as the design and manufacture of a good reputation—a concept with manifold implications. . . . Boil it all down, and you'll find that you are trying to get people to like you, respect you, believe you, or at least listen to you."

That sounds easy. Someone is hired to start talking and writing. He gets busy manufacturing a reputation. But is it that simple? It seems not, to quote Mr. Patrick again.

"No public relations counselor, regardless of his certifications, can by his own efforts make a sick company well or make a bad company good in the eyes of its employes, customers, and neighbors. He can't sit in an ivory tower and create speeches, statements, advertising, and business policies that will alter the situation in the slightest. Some think they can. Unfortunately, too many business executives think they can. Bad human relations are not cured so simply."

Judging from Mr. Patrick's remarks and those of many others in the field, there must first be something to talk about, a topic or topics that can be spoken on with pride. There must be honest substance of good human relations on the one side. The job to be done by the public relations operation then becomes definable. It is communications. On this, too, Mr. Patrick has some pungent thoughts.

"The primary tool of public relations practice, communications is neither a fancy word nor a new science. As practiced over the back fence, effective communication occurs when someone tells you something about himself, his family, problems, or ambitions, and you listen and comprehend. One man tells another. It's as simple as that. Trouble arises when one of these men is a manager of a billion-dollar business, a political leader, or the head of a union and the other man is multiplied by 1000 or 10,000 or a 100,000 scattered about the country in various economic and social circumstances. And so the job of efficient communication takes on complexity.

"The public is a lot of people—a little frightening en masse—and best taken one at a time. You begin by dividing it into smaller groups of special publics, or audiences, who have a personal interest in what you say and do and in whom you have a complementary interest.

"A company does not exist on paper, on film, or in the speeches of its top men—but in every contact it makes with each man, woman, and child. A company's reputation does not lie solidly in the hands of its officers, managers, and advertising agencies. Every employe and each of his relatives and neighbors, as well as every product distributed, influence reputation. And a lot of people who aren't even on the payroll—independent merchants, contractors, servicemen, telephone operators, truck drivers—determine what millions think about a company.

"Even if General Electric were to disregard these people, we still have 210,151 employes who go out of our offices, plants, and laboratories to live their own lives among other human beings. What any one of them says about the company over a bridge table or a back fence carries far more weight than anything we would say officially in the *Saturday Evening Post* or the *Cleveland Plain Dealer*.

"And thus we come back to the art of communication. Today we can prove that primarily most people's opinions result from person-to-person conversations and only secondarily from something they read, see, or hear.

"A professional mystery does not surround the practice of public relations. Its success depends on effective communication, on mobilizing the understanding help of everybody in an organization, and on never forgetting that the public is people—one at a time."

As was said at the beginning, there is a tide toward increasing use of the tool of public relations by management in the mineral industry. It is to be hoped that the industry gets its money's worth.—R. A. B.

◆◆◆◆◆◆

ALTHOUGH the 1955 meeting of the American Mining Congress was held this year at Las Vegas, Nev., October 10 to 13, the mining men attending had more than the flip of a card and the turn of a wheel on their mind. Tariffs and taxation, national policies in the mining industry, labor and management problems, public relations, public lands, stockpiling, gold and silver, and markets took up almost half of the program. A total of 16 resolutions on these subjects were offered.

The proposed CIO-AFL merger, the principle of a guaranteed annual wage, and aggressive political activity by the unions were regarded with suspicion; the recommendations of the second Hoover Commission were recommended for adoption as were more funds and a centralization of scattered activities for the U. S. Geological Survey and the U. S. Bureau of Mines; assurance by the AEC of a future market for uranium ores; and prohibition of compulsory unionism, labor monopolies, enforced political contributions, compulsory bargaining, and mass picketing, and other terroristic devices used by the unions.

Other resolutions recommended state regulations concerning mine safety and air and water pollution, but opposition to ceding to the states rights to public lands that would interfere with mining locations under the general mining laws; some revision of the Securities and Exchange laws and liberation of loans for worthy mining enterprises; and rejection of proposals for international commodity trade agreements. Stockpiling of strategic materials, with adequate financing, was endorsed, with adequate prices paid to domestic producers to encourage development and expansion of production; but the United States should cooperate with foreign governments in their efforts to attract private investment in their mineral development. Gold mining in the United States should be supported by allowing U. S. citizens the right to own, buy, and sell gold; by restoring the gold standard, with free convertibility; and by fixing the gold content of the dollar at a price that reflected its existing depreciation.

Senator Bible of Nevada in a talk before the Congress, however, painted a dim picture of the likelihood of the Government doing anything to help the gold producers. The outlook for higher prices, he thought, was just about as black as the ace of spades. The other Nevada Senator, George W. Malone, criticized the AMC resolution on tariffs as being much too weak and without teeth, he being a high tariff advocate. Senator Anderson of New Mexico and others criticized the Atomic Energy Commission for not telling the domestic uranium mining industry more about what is going on and what might be in store for them in the future. Criticism of labor union practices naturally aroused the ire of Nevada labor officials, who were quoted in the press as branding the AMC action "assinine and ridiculous."

There were technical sessions on milling and metallurgy, exploration and geology, drilling and roof support, open pit mining, industrial minerals, and new mining methods and equipment, which rounded out an interesting and instructive program. A report on these aspects of the meeting appears on page 1062 of this issue.—E.H.R.

CORRECTION: In *World Trade in Lead Metal and Concentrates,* International Mineral Trade Series, Part VI, September issue, pages 856 and 857, the lead exported by Northern Rhodesia should be shown as lead metal, not concentrate. Necessary corrections should be made in Table VIII and in the map showing movement of lead concentrate.

Cyanamid REAGENT NEWS

"ore-dressing ideas you can use"

Lead Recovery and Grade Improved with AEROFLOAT® 242 *Promoter*

AEROFLOAT 242 Promoter is a powerful, selective galena promoter with limited frothing properties. It is water-soluble and is usually fed as a 5 to 10% water solution. The following data show results before and after using AEROFLOAT 242 in the lead circuit of a modern lead-zinc mill. (In both cases SODIUM AEROFLOAT® Promoter is the zinc collector):

Reagents lb./ton		**Previously**	**Currently**
Former Reagent		0.10	—
AEROFLOAT 242		—	0.08-0.10
Frother		0.15	0.05
Product			
Lead Conc.	% Pb.	80-82	83
	% Fe	2.25	1.25
Zinc Conc.	% Zn.	62	63
	% Pb.	0.5	0.25

The use of AEROFLOAT 242 not only improved the grade of the lead concentrate, but also reduced frother consumption. Where necessary for additional frothing with AEROFLOAT 242, we recommend a higher-alcohol frother such as AEROFROTH® 70, 77 or 80 Frothers or the water-soluble AEROFROTH 65 Frother.

Cyanamid has a flotation chemical for every flotation use. These include AEROFLOAT Promoters, both liquid and dry, AERO* Xanthates, AEROFROTH Frothers, various modifying agents and fatty acid promoters. We will be glad to discuss your flotation problem. A note to our New York office will get prompt attention.

*Trade-Mark

AMERICAN Cyanamid COMPANY

MINERAL DRESSING DEPARTMENT

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Cable Address — Limenitro, New York

NORTH AMERICAN CYANAMID LIMITED
Royal Bank Bldg., Toronto 1, Ontario, Canada
CYANAMID DE MEXICO, S. A.,
Apartado No. 26012, Mexico 12, D. F., Mexico

CYANAMID PRODUCTS, LTD., Bush House, Aldwych, London W. C. 2, England
SOUTH AFRICAN CYANAMID (PTY.) LTD., P. O. Box 7552, Johannesburg, Union of South Africa

E. P. CADWELL, Casilla 12983, Correo 11, Santiago, Chile
G. B. O'MALLEY, MALCOLM GLEN, 377 Little Collins St., Melbourne C. 1, Australia

Printed in U. S. A.

complete line of HEAVY-DUTY cords helps you

PICK THE RIGHT CORD FOR YOUR JOB!

Now—Anaconda introduces new portable cords with rugged construction . . . peak performance . . . and top flexibility for 3 types of service!

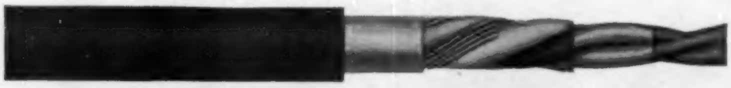
Severe applications . . . Hard usage . . . Standard service — Anaconda brings you 3 new engineered cords designed with the exact physical properties needed for each type of job—strength, flexibility and resistance to wear!

Select the cord *best suited* to your needs—based on good engineering and sound economics.

Whichever cord you choose, the Anaconda trademark is your assurance of *premium performance.*

SECURITYFLEX—Underwriters' approved Types SO and SJO.

INDUSTRIAL—Underwriters' approved Types SO and SJO.



SERVICE—Underwriters' approved Types S and SJ.

SECURITYFLEX* CORDS for severest conditions. Toughest, sturdiest cords made . . . used where strength and wear-resistance are a "must." Neoprene jacket *mold-cured in lead* gives top crush, abrasion- and oil-resistance. Cords pay for themselves with long life under severest conditions—in mines, railroads, docks, and in heavy industrial use. Look for the molded-in name, "Securityflex!"

INDUSTRIAL CORDS for heavy industrial conditions and *maximum flexibility.* Lower in cost. Specially designed for use in heavy industry—where cords are in continuous operation and must be tough, flexible, oil-resistant. Tough neoprene jacket. Many industrials stock this one cord for use in virtually all applications . . . reducing inventory problems and costs. Look for the Anaconda marking on jacket.

SERVICE CORDS for regular duty. Lowest in cost . . . yet have many features found only in higher priced cords of other makes. Special rubber jacket withstands abuse and moisture. Outstanding for appliances, office machines, portable tools—where flexibility and long life are needed.

*Reg. U. S. Pat. Off.

see the man from . . .

ANACONDA®

about your

PORTABLE CORDS

FREE "PORTABLE CORDS" BULLETIN

Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

Gentlemen: Please send me your new free "Portable Cords" bulletin, DM-5538.

NAME & TITLE..

COMPANY..

ADDRESS..

CITY, ZONE, STATE..

MINING engineering

DRIFT

★★★★ Hats off to INCO for producing *Mining for Nickel*, the best film on mining we have yet seen. Had it been produced for the neighborhood movie house, this film on the mining operations of the International Nickel Co. would rate four stars, four bells—whatever was the critics' highest praise. It has everything: sound, color, and for a cast the great nickel orebodies of the Sudbury Rim. The plot consists of finding, developing, and extracting these ores. Prospecting provides the suspense; engineering solves the case; management carries the job to completion.

This 45-min film achieves two almost incompatible ends. It is intelligible to nonmining people (at the preview we sat next to a man who had never been in or at a mine) and at the same time holds interest for viewers with more experience in mining. It begins with the history of the Sudbury finds with scenes of early day prospecting. The story then turns to the modern counterpart of the man with the pack and the pick—the geologist equipped with the latest in geophysical techniques. The film clarifies the role of aerial geophysical reconnaissance while pointing out that an anomaly isn't necessarily ore!

From discovery, the film turns to problems of mine development, diamond drilling, mining layout, and shaft sinking. Again it gets across a vital point in showing why a company cannot bring new production into being in a moment or a month. It graphically shows the years of effort required to develop a major new orebody.

The next stage is that of actual extraction, of getting the ore out of the ground. Here the Sudbury setting provides such a variety of orebodies that almost every type of mining method is illustrated. Open pit and block caving operations are shown as well as shrinkage, slicing, caving, and square-set stoping methods.

One of the clearest expositions of mining methods ever devised is created by the interweaving of animation with color action shots taken on the surface and underground. The combination of movement, depth effects, and color conveys the feel of underground mining operations. Color provides the ultimate separation of strata and areas, while movement and depth give the sense of continuous process at work in a going mine.

The film was two years in the making, and that period must have included a great deal of effort throughout the International Nickel Co. organization. The facts are straight. Those two years also represent terrific effort and ingenuity on the part of the staff of Film Graphics Inc. who produced it for INCO. They came up with some amazing shots.

This is the sort of film that every student entering college in mining or related fields should see, and one that he might well see again when he advances to courses on mining methods. It should also prove a stimulus to prospective mining students at the precollege level. And it would certainly help nontechnical management and financial people grasp some of the problems being met every day by operating personnel. Where else might it be useful? To show to almost any audience with any interest in mining. The commercial message is brief, in good taste, and at the end.

How to see it? Prints of "Mining for Nickel" are available for educational, industrial, and civic groups from the *Douglas D. Rothacker, Jr. organization, 729 Seventh Ave., New York City*, or from *The International Nickel Co., 67 Wall St., New York City.*

UNDER the heading "The End of an Era" *The Mining Magazine* (London) reports that the last Cornish pumping engine at work in Cornwall was "superseded by electrically driven centrifugal pumps." While we might quibble with the word *superseded*—it seems likely they were superseded long ago designwise—the replacement is a landmark in mining history. These were the devices that made deep mining possible almost two centuries ago.

FOR seven nerve-wracking days the Adirondack iron mining town of Witherbee, N. Y., shared a common hope with Kings County, better known as Brooklyn. The chips were down, the issue clearly drawn. Could Brooklyn come through the World Series against the Yankees? Could they break the jinx and finally take a series?

Brooklyn may have been worried, but that was nothing to the feelings of the iron miners and their families in Witherbee. They weren't worried whether Brooklyn *could* take the World Series—it was just that they didn't know whether Brooklyn would realize that it was Witherbee's Johnny Podres who could do it for them.

As the series went 0-1, 0-2, 1-2, 2-2, 3-2, and 3-3, Witherbee fretted. Then Brooklyn put in Johnny and Witherbee heaved a sigh of relief. Nine innings later the whole legion of Brooklyn fans joined in that sigh when the umpire called the third out.

Johnny's father, a miner for Republic Steel Corp., was in Yankee Stadium for that last game, but the rest of the family and the town had to wait until he came home to celebrate. In fact, so many joined in, that the festivities had to be moved to nearby Mineville, N. Y.

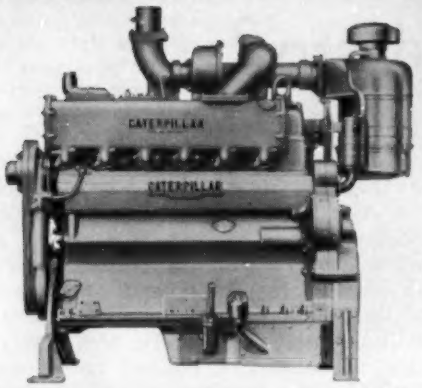
The record will mark 1955 as the year the mighty Casey struck out. And Johnny Podres of Witherbee was the man who did it.

R. A. Beals

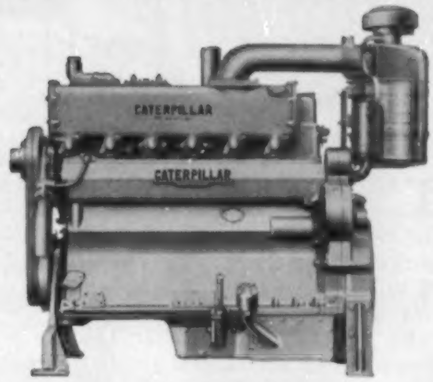
Announcing 2 more new CAT* DIESEL ENGINES

THE NEW D337
Series F with Turbocharger

THE NEW D326
Series F

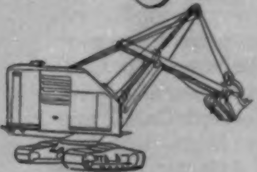


310 HP maximum @ 2000 r.p.m.



200 HP maximum @ 2000 r.p.m.

MODERN, COMPACT, HEAVY-DUTY UNITS FOR



Conveyors	Mining Equipment
Compressors	Electric Power
Cranes	Auxiliary
Excavators	Full time
Hoists	Portable
Locomotives	Pumping

Rock Crushers

Available as original power in many types of equipment . . . direct drive or choice of transmissions, including hydraulic couplings and torque converters. Also available as Electric Sets and Marine Engines.

CHOICE OF 3 STARTING SYSTEMS

AIR—For fast starts where a supply of compressed air is on hand. Also available: air compressors and storage equipment.

ELECTRIC—Where speed of starting and convenience are important. Also available: automatic start-stop controls which require no operating personnel.

GASOLINE—For all-weather starting. Preconditions the diesel and lubricates before the diesel is started. Also available: electric starters for the gasoline starting engine.

Here are the two newest diesels in the Caterpillar line. They offer you more for your money than *any* engines in their power range. Combining major advances in design with time-tested Caterpillar features, they're built to deliver more power with less maintenance and lower cost. For example:

• New Turbocharger (in the D337 Series F) utilizes exhaust heat to drive supercharger. Delivers air in direct proportion to engine's need. • New hydraulic valve lifters practically eliminate valve adjustment, provide quiet operation. • New, improved water jets for more effective cooling. • Heavy-duty, oil-cooled pistons with chrome-faced rings for longer life. • Sealed cooling system reduces mineral deposits. • Full-flow filtering of fuel and lube oils. • Complete line of attachments to meet all your requirements.

All these and other features add up to a new standard of performance. For details, see your Caterpillar Dealer. You can always count on him for reliable information and prompt service!

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

NEW D337 Series F and NEW D326 Series F—LATEST EXAMPLES OF CATERPILLAR LEADERSHIP IN ACTION

MAIL TODAY

CATERPILLAR TRACTOR CO., PEORIA, ILL., U. S. A.

I'd like more information on the new D337 Series F ☐, D326 Series F ☐.

Name__________

Address__________

City__________ Zone_____ State__________

What Will the St. Lawrence Seaway And Power Development Mean To the Mineral Industry?

TWO separate but closely related projects now under construction on the St. Lawrence River—the Seaway and the St. Lawrence Power Project—are providing the impetus for what may become one of the most significant economic expansions in the Northeast.

By 1959, or even earlier, electric power will be flowing from the largest single hydroelectric installation east of the Rockies.

Simultaneously there will come into existence a great new commercial waterway which will provide cheap transportation from the farm and industrial heartlands of the U. S. and Canada to the markets and resources of the world. When the Seaway is completed, vessels with five to ten times the capacity of those now using the Canadian canal system will be able to move from the Atlantic Ocean to Lake Superior.

St. Lawrence Power

In August 1954 construction of the Power Project was begun jointly by the New York Power Authority and the Hydro-electric Power Commission of Ontario. Costs and the power developed are to be shared equally.

Construction work is now well along and with some minor exceptions is on schedule. The goal is power by late 1958, completion of the project in 1959.

A dam near Iroquois, Ontario, will regulate stream flow. Another dam near Massena, the Long Sault Dam, will close the south channel of the river and divert the entire flow to the main channel. All power will be generated at the lower end of Barnhart Island. Total theoretical maximum capacity will be about 1.88 million kw with a steady, firm power of 1.4 million kw, to be divided equally between the New York and Ontario agencies.

The rates at which power will be sold are yet to be determined by the Power Authority. A portion of the power must be reserved for users in nearby states under the terms of the 50-year license granted the Authority by the Federal Power Commission. A 42-year contract has been negotiated with the Aluminum Co. of America to supply 174,000 kw of firm power and 65,000 kw of interruptible power for its plant at Massena. The average cost of this power will probably be about 4.4 mills per kw hr.

The Seaway

The St. Lawrence Seaway will provide a new system of canals with seven locks between Montreal and Ogdensburg and improved river channels. With the eight existing locks of the Welland Canal and the U. S. locks at Sault Ste. Marie, Mich., this will provide a 27-ft channel from the Atlantic to Lake

Aluminum Co. of America's plant at Massena, N. Y., is already a large user of St. Lawrence power. It is generated in its own powerhouse shown in foreground. Completion of the power and Seaway projects will eliminate this power source for Alcoa, but a new contract with the New York State Power Authority will provide the plant with up to 239,000 kw when the Seaway is completed. Changeover to 60 cycle current involved in new contact is estimated to cost about $25 million.

This is the Long Sault Cofferdam nearing completion. The permanent dam to be built here will divert the swift-moving St. Lawrence River to the main channel. Power will be generated 4 miles downstream at the Barnhart Island Dam site. This is only one of about a dozen major construction projects that transform the whole area into one super project, and overall construction on the power development is estimated at $600 million. The Seaway work, which includes construction of two locks, as well as extensive channel development and dredging, will run the total up over $750 million.

Superior. Traffic is scheduled for 1960.

The location of new industry in this area will be governed not only by Seaway transportation but also by the availability of labor and the economy with which raw materials can be supplied. It seems reasonable to assume that power-oriented industries will be attracted to the St. Lawrence region, and in this field are the electrochemical and the electrometallurgical industries.

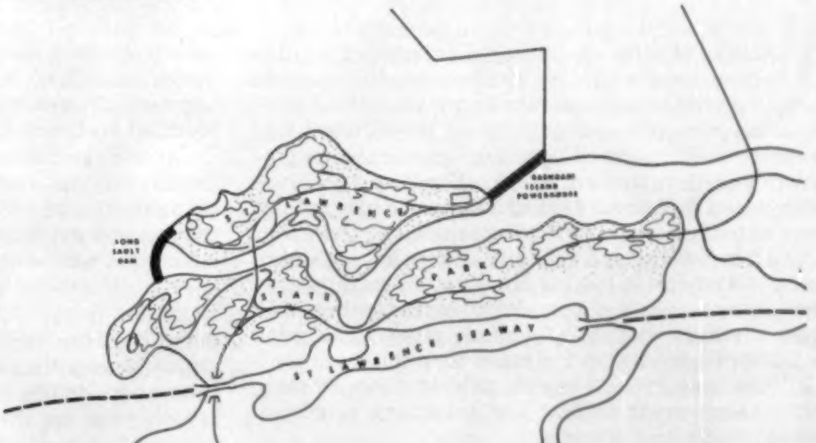
The Future

What will all of this mean to the mineral industry? The nearby Adirondack region is now a major iron ore source, with production from three districts, and the same region is the nation's largest single source of titanium. Lead, talc, and garnet are among the other minerals produced in noteworthy amounts. It seems more than probable that along the stretch of Seaway to be opened to low-cost power that the conjunction of raw material availability, water transport to the industrial centers of the Midwest, and rail or canal connection to the cities of the Northeast will prove irresistible to major industries.

Some of the cities now talk of a steel making center, while others envision electrometallurgical plants of the scale of Alcoa's Massena Works. Several chemical companies have reportedly optioned plant sites in the area. The only factor likely to spoil these dreams seriously is manpower—since the area is relatively sparsely settled. The pattern is likely to include development of several industrial units characterized by high electric power needs, coupled with the growth of small manufacturing plants in a more gradual pattern.

SITE OF MAJOR CONSTRUCTION ACTIVITY

The map shows the overall layout of the projects in 1958, after completion of the major construction, and the flooding of several areas. The Seaway route involves construction of the Richardson Bay Lock to the west and the Grass River Lock to the east. Dotted line shows approach to these locks. The Barnhart Island Powerhouse lies astride the International Boundary and the power to be developed there will be shared equally by the U. S. and Canada. The existing shallow canal system lies north of the area shown, and is within Canada.



Banner Mining Co. Opens

The Mineral Hill Copper Property In Arizona

by A. B. Bowman

BANNER Mining Co. became interested in this Tucson area early in 1950, and after several months of reconnaissance work, a lease-option purchase agreement was concluded on the Mineral Hill property which allowed time for considerable exploration and development work. Unwatering of the mine began in August 1951 after electric power lines were extended from nearby Tucson.

The unwatering and rehabilitation work was done under a Defense Minerals Exploration Administration project and was completed in December 1952 after about 15 months of tedious work. The mine had been under water for more than 30 years with resulting cave-ins and timber deterioration. In some badly caved areas spiling was necessary to reopen the old drifts and crosscuts.

After the mine was opened each level was geologically mapped and more than 500 cut samples were taken in the mine openings which were in ore from the 300 level to the 700 level. Extreme care had to be taken in cleaning the surfaces before the samples were cut to avoid salting, as considerable oxidization had taken place on the exposed areas. Spongy masses of native copper and cuprite had formed on the walls.

At the conclusion of the initial exploration project it was felt that enough ore had been found to justify the erection of a mill and to continue further exploration and development work at favorable locations along the east-west fault zone (see geology section).

A. B. BOWMAN is General Manager of the Banner Mining Co., Tucson, Ariz.

Plant Operation

During the summer of 1952 representative bulk samples were taken of the sulphide ores from the 300, 500, and 600 levels. Test work on these samples, carried out by the Galigher Co. in Salt Lake City, determined that recoveries in excess of 93 pct on the contained copper could be expected.

In May 1953 the Defense Materials Procurement Agency agreed to buy the first 12.96 million lb of refined copper produced from the property for the stockpile and to aid in mill construction.

A 400-tpd flotation plant was designed and erected on the property by J. C. Carlile & Associates of

Location

The Mineral Hill mine, 16 miles south of Tucson and 8 miles west of Sahuarita, Ariz., is in the Pima Mining District. The country is relatively flat with a few isolated buttes marking the landscape. This flat terrain slopes gently toward the east and the Santa Cruz Valley at an average elevation of about 3400 ft.

Climate

The climate is semiarid; the area receives about 10 in. of rainfall per year. Temperatures seldom get below freezing in the winter time and summers are hot and dry with temperatures reaching 115°F. However, this is not too uncomfortable when combined with the dryness of the air and the combination makes for ideal operating conditions through the whole year.

History

Oxidized copper ores were produced from a number of outcrops on the property prior to World War I. An old slag dump of a few thousand tons and a number of shallow surface stopes are mute evidence of early small-scale mining which was in progress shortly after the turn of the century.

The Mineral Hill Consolidated Copper Co., a subsidiary of the Barnsdall Oil Co., acquired the property about 1914 and shipped 46,000 tons of ores averaging 3.5 pct copper in the period 1915 to 1917. From 1917 to the spring of 1920 this same company did considerable development and exploration work to a depth of 700 ft, but in an area limited to a few hundred feet of the shaft. A depressed mineral market and the installation of new officials heading the parent company whose interest was primarily in oil concluded all mining ventures by the Barnsdall Co.

Denver. Space was left in the mill building for an additional grinding and flotation unit of equal size. The crushing plant was designed to reduce 50 tph of mine ore to $-\frac{3}{8}$ in., making possible further additions to the grinding flotation sections without additional crushing capacity.

The mill was tested in May 1954 and put into full operation in June. A total of 83,000 tons of sulphide ore having an average assay of 2.20 pct copper was milled in 1954. Average recovery of the copper up to the present time has been approximately 94 pct.

Water in the mine is adequate for the operation of the mill and other camp needs, but a 60-ft diam Dorr thickener is used to thicken tailings and to return makeup water to the mill circuit. Diamond drillholes in the hangingwall limestones have located additional water which is controlled by valves cemented in the holes. This situation is ideal, as only requirements for mill, mine, and camp totaling 150 gpm have to be pumped. A major portion of the water is collected in a sump below the 600 level and is pumped in one lift to surface storage tanks. An alternate system for handling in two stages is also provided for use in emergencies.

Mining Operations

The two shafts at the Mineral Hill mine were rehabilitated before production began. The two-compartment vertical shaft is used for personnel and supplies. The two-compartment inclined muck shaft equipped with a 250-hp Vulcan single-drum hoist and 2½-ton self-dumping skip can hoist 50 tph from loading pockets on the 500 and 600 levels. The 100-ton ore bin and 75-ton waste bin located in the headframe at the inclined shaft were designed for quick unloading into 18-ton dump trucks for transfer to mill coarse ore bins and to the waste dump.

The mining method varies according to the type of ore that is encountered. On the 600 level of Mineral Hill a large, flat, dipping zone of hard garnetite-chalcopyrite ore was developed. This orebody measured about 300 ft long and 80 ft in horizontal width, with an average dip of 30°. Both the hangingwall and the footwall were irregular, making limits difficult to follow.

To prepare this block for mining a 12x12-ft double-track haulage drift was driven along the hangingwall. Raises near the ends of this orebody, with connecting drifts about halfway between levels, gave additional access to the parallel stopes. The back of this haulage drift was rock-bolted and did not require further support. At 30-ft intervals 8x8-ft stope openings were driven into the ore. These openings, at right angles to the haulage drift, and about 4 ft above the track, continued to the footwall of the ore. Chutes placed at the mouth of these openings extended over the inner track on which a storage battery locomotive moved cars into position for loading.

Slushing: A 25-hp, three-drum electric slusher hoist, mounted on a steel frame with wheels, operates on the outer track. The hoist is anchored by means of rock bolts to the wall opposite each opening before slushing ore from a stope. Pillars protect the back and sides of the haulage drift. The stope sides were drilled and blasted, increasing the width to a minimum of 25 ft. The back was then taken down in 6-ft rounds until the hangingwall was reached and excess ore was slushed into cars after each blast. The pillars which are left between the stopes have openings broken through them at regular intervals for access purposes.

Rockbolts: Both the back and sides of the stopes are rock-bolted on the corners of a 5-ft square pattern where required. The 1-in. diam by 6 ft 6 in. long bolts are of the slot and wedge type. Head boards 3x12x36 in. are used against the ground, together with 8x8x⅜-in. steel washers. The whole unit is tightened by an impact wrench applied to the 1-in. nut. Up to the present time filling has not been required in these stopes.

Drilling and Blasting: Conventional detonators in the blastholes gave considerable trouble in these stopes by producing coarse boulders that slowed down slushing and loading operations in the stopes and at the grizzly over the shaft pocket. Substitution of Atlas Rockmaster millisecond electric blasting caps resulted in much finer fragmentation with a corresponding saving in each phase of handling thereafter. A comparison of results may be seen in the photographs on the following pages.

Medium-weight jackhammers are used on 3 and 4-ft feed legs for all drilling except in raises. A ⅞-in. hex-alloy drill steel is standard for the mine and is used in conjunction with 1⅜-in. gage threaded tungsten carbide four-point star bits. Some

Ore broken in 600 level stopes with regular cap and fuse detonators. Coarse fragments slowed slushing and loading operations in stopes and at grizzly over shaft pocket.

hex steel is used with 1 9/16-in. integral carbide chisel bits in drifts and crosscuts.

Handling Difficult Orebodies

In other areas of the mine near cross faults the ore is soft and badly brecciated and contains considerable chlorite and gouge. The west side of the 300 level is such an area. The orebody on this level of about 20,000 sq ft in area was mined in part by the Barnsdall Mining Co. during World War I.

A 7x8-ft haulage drift was driven along the northeast-southwest fault to the footwall granite to develop the area. Three-compartment raises containing two chutes and a center manway were driven up along the approximate dip of the ore at 100-ft intervals. A 20-ft protective level pillar was left above the drift. One or more raises were extended to the level above. Stopes about 20 ft wide and 100 ft long were advanced between the raises in horizontal cuts 8 to 10 ft high.

Rock bolts are used to support temporarily the back and hangingwall while the broken ore is slushed to the nearest chute for transfer to the haulage level below Filling is then required for the permanent support of the walls. At present the sand portion of the mill tailings is utilized to fill these stopes. The walls of these stopes are tested to a depth of up to 60 ft by longhole drilling as the stopes progress and the sludges from the longholes are sampled in 5-ft sections to determine the grade of future adjoining parallel stopes.

Sand Filling

Sand fill for the stopes is prepared in a plant located near the collar of the main shaft. A steel tank 14 ft diam by 16 ft high is equipped with a heavy duty propeller type agitator and a 10-in. single-stage cyclone is mounted over the tank. Mill tailings are pumped into the cyclone by a 3-in. sand pump at 30 psi. The sand portion of the tailings or the underflow of the cyclone containing about 50 pct of the total tailing falls into the agitator tank. The slime portion containing about 90 pct —325 mesh material is returned to the mill tailing thickener for transfer to the tailing pond. Two 50-ton pours are made per shift when the required amount of sands has accumulated in the storage tank. Sands are kept in agitation prior to a pour at about 78 pct solids.

Mineral Hill's Geologic Setting—

Structural Control: The east-west pre-ore thrust fault traverses the property for a distance of about 5500 ft with some offsets which are minor in character, except for one of about 400 ft. Over much of this distance the fault is covered by alluvium. From data observed to date the ore mineralization is localized along this fault zone at and along intersections with cross faults at or near intrusive contacts in limestones and quartzites. It is possible that this east-west fault may be a strand of a deeper flat thrust fault. The sedimentary rocks strike roughly southeast and have dips varying from 0° to 90° with some overturning.

Copper ore deposits at the Mineral Hill mine are of pyrometasomatic type. The main deposit is formed in the sedimentary rocks near the fault contact with a granite stock at or near the intersection of two faults. There is an east-west thrust fault dipping about 50° to the south and a northeast-southwest fault which dips steeply to the southeast.

The copper ores occur in this trough as replacements in the limestone along shear zones and as disseminations in the contact silicates. The main copper mineral is chalcopyrite with small amounts of chalcocite and bornite. Associated minerals are magnetite, pyrite, and small amounts of sphalerite, molybdenite and scheelite. The gangue consists of limestone, marble, garnetite, epidote, chlorite, quartz, and jasperoid. In part of the mine below the 300 level granite forms the footwall of the east-west fault.

Fragmentation in 600 level stopes when Atlas Rockmaster millisecond electric blasting caps were used. Savings were brought about in each subsequent phase of handling.

A 2-in. victaulic pipeline connecting the sand tank to the stopes is free of valves except for one rubber pinch valve controlling the sand flow which is located at the collar of the shaft. All bends in the line are of the sweep type to avoid excessive wear and to keep friction at a minimum.

An independent telephone line has been installed for direct communication between the sand plant operator and the sandman in the stope. The portable Army field-type telephones used are equipped with long extension cords so that the operators can move about to observe all phases of the filling operation. Separate water and compressed air connections have been installed in the sand line at the surface to permit the addition of more water if needed and to wash out the sand line at the beginning and end of each pour. Compressed air is used to aid in cleaning obstructed lines. The time required for a 50-ton pour is about 40 min and begins after crevices in manways, chutes, and other openings have been covered with burlap. Heavy duty Bostitch H-4 stapling hammers are used to tack the burlap in place. Hi-early quick setting cement is used for sealing along with the burlap at joints between timber bulkheads and ore wallrock.

Water drains from the sand fill quite rapidly and drainage is aided by strategically placed wooden *mousetrap* drains. Within an hour a man may walk out on the fill without danger. The sand packs rapidly, thus enabling men to return to the stope to continue drilling and blasting within about 8 hr of pouring.

Daisy Shaft Development

Further exploration along the east-west fault zone to the east of the present operating mine led to the discovery of new ore at and near what is now called the Daisy shaft. Located 4000 ft east of the Mineral Hill shaft, the Daisy shaft was sunk 450 ft to explore one of these new ore zones found by diamond drilling. Some of this ore came within 25 ft of the surface and was localized along a fault striking northeast to east. This fault is apparently a segment of the Mineral Hill fault zone which has been offset by a north-south post-ore fault. Ore occurs along the northeast-striking fault in sedimentary rock in a zone near the boundary between Permian limestone and Arkosic quartzite. The quartzite is mineralized, but the highest grade ore is found in the limestone at the footwall of the zone. The oxidized ore attains widths up to 40 ft with the grade diminishing in proportion to the distance from the footwall limestone.

About 13,000 tons of the oxidized ore, averaging 6 pct copper, were shipped to the smelter during 1954. The copper minerals found in the upper 250 ft of the Daisy orebody include malachite, tenorite, melaconite, cuprite, azurite, chrysacolla, chalcopyrite, chalcocite, and native copper. Some of this ore has been of specimen grade and is in demand by collectors.

At the present time development and exploration work is proceeding on the 200, 300, and 400 levels of the Daisy shaft. A total of 2500 ft of drifting and crosscutting has been driven on these levels to date. More compressor capacity, a larger hoist, and steel ore bins will expedite this program. A larger low grade copper deposit in the vicinity will also be tested from this shaft.

The area along the Mineral Hill fault between the Daisy and Mineral Hill shafts is now being tested by diamond drilling. Widths of up to 80 ft of low grade oxidized ores have been encountered at bedrock beneath about 100 ft of alluvium. Deeper drillholes to check the sulphide zone are contemplated and will be drilled shortly.

Accounting Provides Control: A comprehensive cost accounting system has been installed to provide detailed breakdowns of all phases of the mining operation, which includes stoping, development, exploration, maintenance, haulage, hoisting, waste disposal, new construction, drainage, ventilation, shipping, and selling. The detailed cost accounts make it possible to get quickly to the heart of problems that arise to push individual costs out of step with other aspects of the work.

Acknowledgments: The author wishes to thank Boyd Venable, mine superintendent, and F. D. Mackenzie, mine engineer, for their valuable aid in the preparation of the paper. Geological information was developed by Harrison Schmitt and Boyd Venable and is herewith acknowledged with thanks.

Vendome Solves Water Control Problem—

Grouting a Mud Seam

by P. R. Geoffroy, J. A. Lawrence, and U. Max

WHEN shaft sinking was begun on the Vendome Mines property in the Barraute area of northwestern Quebec, there was no indication of the flat mud seam that was later encountered, and no special precautions were taken in applying conventional methods of grouting. Failure of the first cementing attempt emphasized the important fact that mud is an adverse condition in grouting.

A method was then devised that would remove the clay from those portions of the seam adjacent to the shaft, replacing it by a bulky mixture of cement and sawdust. Tests were carried out to insure that the seam had been properly sealed and that excavation could be resumed without endangering the shaft.

To begin sinking the present shaft, which contains three 5x5½-ft compartments, a concrete caisson had to be dropped through 62 ft of glacial drift. It proved difficult to seal off the waters at the casing shoe level, not only because the bedrock was shattered but also because it was necessary to pump as much as 2500 gpm of water existing at the bottom of the overburden. Beginning Jan. 1, 1954 four months of grouting were necessary.

On June 1 drilling ahead of the first section of the concrete collar disclosed a flat seam, 14 ft below the casing shoe and 5 ft below the shaft floor, which gave off a considerable amount of water (maximum flow, 850 gpm). The seam had not been reported in the log of an exploratory hole drilled on the shaft site. This water-bearing fracture later proved to be 18 in. wide, consisting of crushed lavas cemented with clay. Below the glacial drift it probably outcrops to the north of the shaft and feeds into the same large water pond that surrounds the casing.

The schedule of grouting operations, which lasted from June 1 to July 7, is shown on page 1027.

First Grouting Attempt

Presence of a large amount of clay in the seam remained at first unsuspected, as only clear water was given off during early days of cementing. Conventional grouting was therefore attempted.

Each day the morning shift drilled a row of eighteen 10-ft 1-in. diam holes. These were evenly distributed along the perimeter of the shaft section and equipped with pipe and valves. Grouting took place in the afternoon and early evening, about 12 hr being allowed for the grout to set. The grout used consisted of equal proportions of Portland cement and cement Fondu pumped into the seam under a maximum pressure of 1500 psi.

P. R. GEOFFROY is a Consulting Mining Engineer and President, Vendomes Mines Ltd., Montreal. J. A. LAWRENCE and U. MAX, are respectively, Superintendent and Shaft Captain, Patrick Harrison & Co. Ltd.

On June 11 seepages only were struck in the test holes drilled on that day, with the exception of a single hole yielding a limited flow. Fifty-two bags of cement were pumped through the wet holes, bringing to 708 the total number of bags injected since June 1. The seam was then considered sufficiently sealed to allow the excavation to be resumed and the collar extended farther down.

However, while grouting was in progress clay and sand had started to leak from test holes in increasing quantity. As clay was present in the seam, it was possible for mud clogs to form between already cemented areas. Such plugs would temporarily seal off outside waters, but as excavation proceeded they were liable to be washed out, letting water re-enter the shaft. With this possibility in mind, it was decided to resume shaft sinking with utmost precautions and to note carefully to what extent blasting would induce or increase seepage.

On June 13 a 2-ft high bench was taken over the western half of the shaft section. During the ensuing night, after a considerable amount of clay had discharged into the shaft, it became flooded. It was found after the shaft was pumped dry that a cavity had formed in the center of the floor, reaching to the seam below, while the test holes previously left dry had turned wet, some of them giving off a considerable flow of water under high pressure. Obviously the seam was still wide open.

Repairing the Floor: To allow grouting of the seam to be resumed, it was necessary to repair the shaft floor and make it both impervious and strong enough to withstand the grouting pressure.

Over the central section of the floor where a cavity had formed, a mat was laid consisting of 2-in. planks placed on a heap of paper bags covered with tarpaulin and held together by more 2-in. planks nailed crosswise. Three 8x8 beams were then laid over the planks and their ends inserted below the collar walls. Wedges forced between the beams and the collar served to tighten the mat.

A mixture of cement (both Portland and Fondu) and coarse sawdust, in equal volumes, was pumped through existing test holes. After three days of grouting all seepage had disappeared. However, a new cavity formed, this time in the eastern section of the shaft. A similar mat was placed over that section, pinned to the walls and overlapping the first to provide a difference of level, making room for a sump. Grout was pumped in for two more days, when again fissures appeared in the floor, located in the western and still exposed section. By that time four sump pumps and a Rex gas pump had to be operated to control the flow of water given off. The mat was extended over the whole shaft area and grouting carried on for three more days, partly through the mat, partly through the collar walls.

On June 25 following the injection of 418 bags of cement and a comparable volume of sawdust, seepage from the floor had been completely cut off. After two days had elapsed for the cement to harden, the repaired floor was deemed strong enough to withstand the grouting pressure and on June 28 cementing of the seam was resumed.

Second Grouting Attempt: While the disrupted floor was being repaired, careful consideration was given to the nature of the problem faced and the most practical ways of solving it. Obviously the large amount of clay present in the seam would not permit building a continuous and impervious cement plug, as mud clogs were forming, preventing the grout from reaching certain sections of the seam.

The most efficient way to cause disruption of the mud plugs and induce a discharge of clay into the shaft would have been to apply, in rapid succession, positive and negative pressures in test holes. That is to say, to pump clear water under high pressure into a test hole and then let the hydrostatic pressure (about 20 psi) act on the plugs in an opposite direction, repeating the sequence until a discharge of clay was obtained.

However, as such a method would have been impractical, the following procedure, based on somewhat similar principles, was finally adopted and put to work.

Test holes, 10 ft long and 1 in. diam, dipping away from the shaft at an angle of 60°, were drilled through the collar walls by the morning shift and equipped with pipe and valve. The pressure and nature of flow, if any, were recorded for each of them. To open some of the holes found dry or simply leaking, clear water was injected. under pressure, with the grouting pump. Pressures and flows were again recorded. Wet holes were then allowed to bleed until a flow of clear water was noted everywhere, usually after a couple of hours of free bleeding. Grouting followed immediately.

All dry holes were left open for the night under close supervision. The hydrostatic pressure acting on these holes caused some of them to burst open and discharge a further quantity of clay. These holes were grouted the following day together with the wet holes drilled on this day.

Coarse sawdust and a mixture of equal parts Portland cement and cement Fondu were used as a bulky filling to replace the clay given off. The proportion of sawdust, at first up to 50 pct in volume, decreased as grouting proceeded until only pure cement was pumped in. During the second and final attempt 260 bags of cement were injected into the seam.

A sketch, shown below, was drawn every day, showing location of the test holes and nature and pressure of the flows and seepages observed, first at drilling time and then following water and grout injections. The sketches illustrated the way grouting was proceeding and outlined areas where mud was accumulating.

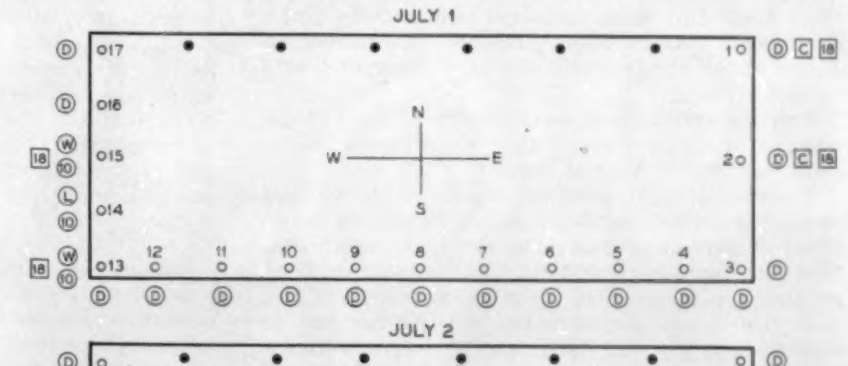
The sequence of events that took place on July 1 and 2 is an example of the grouting procedure, see sketches. On July 1 the situation was as follows: The northern section of the seam had been sealed on June 28. Test holes drilled on June 29 through the north wall of the shaft and found dry had not since then developed any seepage.

Nine test holes drilled through the south wall on July 1 proved dry and remained so after pressure was applied to them. This section of the seam then looked as if it had been sealed too. However, the fact that this result had been obtained on the previous day by injecting cement in a single hole located in the east wall cast a doubt on the efficacy of the sealing.

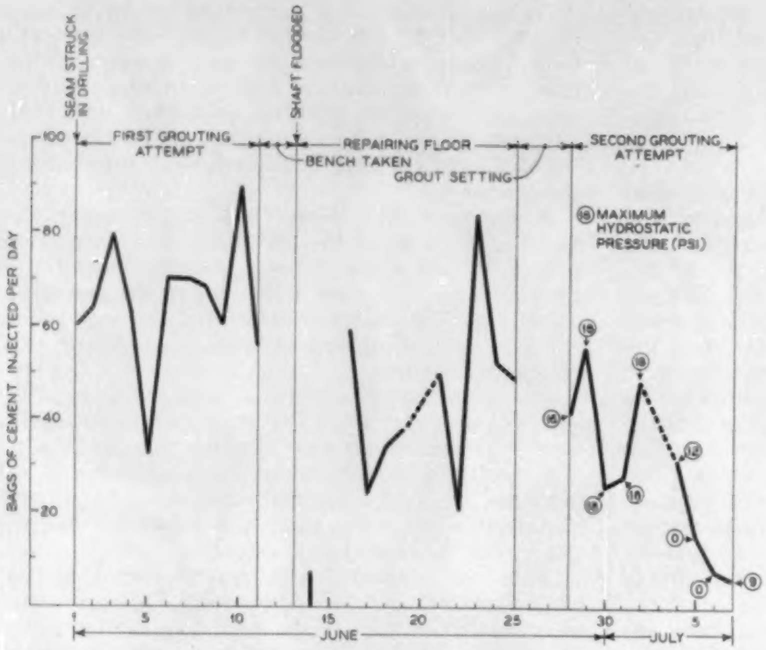
As shown in the diagram, water injection in the holes drilled through the east and west walls caused some to open up and discharge clay under a pressure of 18 psi, the maximum pressure registered so far.

As soon as a clear water flow was obtained from all bleeding holes, 28 bags of cement and 4 large bags of sawdust were pumped in. The dry holes, equipped with pipe and valve, were left open for the night.

At 2 o'clock the following morning, seven of the nine holes in the south wall burst open, discharging a considerable amount of clay under a pressure of 18 psi, while three holes in the north wall started to leak. Cementing through the bleeding holes was carried out by the morning shift, using 33 bags of cement and 6 bags of sawdust. New holes were



Daily sketch showing location of test holes and nature and pressure of the flows and seepages observed, first at drilling time and then following water and grout injections. Circle denotes test hole; solid circle denotes hole drilled previous day, found dry, and kept open. Letter *D* denotes *dry*, *W* indicates *flow*, *L* shows *leakage*, and *C* indicates *clay discharge*. Gage pressure is 18 psi. Circled symbol denotes datum taken before or immediately after drilling test hole. Symbol squared denotes datum taken after water or grout injection. Note that dry holes along south wall, shown in upper section of diagram, opened up during the night of July 1, discharging a considerable amount of clay.



Maximum pressure that could be expected, as calculated from data previously collected, was of the order of 20 psi. As shown in the diagram at left, a maximum pressure of 18 psi was read from the gage up to July 2. From July 2 on, pressures went down rapidly. The events that took place on June 1 and July 2 establish that temporary seals may cut off all pressure readings.

drilled through the east and west walls. Grouting through the wet holes took place in the evening, 15 bags of cement and 2 bags of sawdust being injected.

From July 2 on, no other flow of consequence developed from the southern section of the seam, and grouting was concentrated in the western, northern, and eastern sections, where water and mud were still struck in decreasing quantity and under decreasing pressure.

Tests Carried Out

Measuring hydrostatic pressure in test holes is the best way to test the degree of efficacy reached in any grouting operation to seal off a water flow. In the present case the maximum pressure that could be expected, calculated from data previously collected, was of the order of 20 psi.

As shown in the diagram above, a maximum pressure of 18 psi was read from the gage up to July 2, establishing that up to that date outside waters had had free or nearly free access to the shaft excavation. From July 2 on, pressures went rapidly down, eventually disappearing. Pressure reoccurred on July 7 but in one test hole only, and associated with limited seepage.

Pressure and seepage were rightly ascribed to the opening of a minor artery that was grouted on the same day with 6 bags of cement.

Total absence of pressure, while indicating that definite progress is made in sealing off waters, is not proof of perfect sealing. The events reported that took place on June 1 and July 2 establish that temporary seals may cut off all pressure readings.

A graph was drawn based on the number of cement bags pumped daily into the seam with the hope that it would bring forth additional information on the degree of sealing reached on July 7. The jagged shape of this graph clearly confirms the assumption that from time to time mud clogs were forming, preventing the grout from reaching certain parts of the seam and cutting down the number of bags injected per day. These clogs were later on washed away to reoccur elsewhere in the seam.

The drop in cement consumption noted on June 11, when the seam was first given as sealed, does not differ in character from other drops recorded both before and after that date. To the contrary, the decrease in the number of bags handled per day that begins on July 2 not only brings down the daily consumption to a few bags, but is both gradual and regular. This fact, coupled with the disappearance of any hydrostatic pressure in the test holes, definitely supports the conclusion arrived at that the seam was properly sealed.

Completing the Collar: Two days, July 7 to 9, were allowed for the grout to harden. As no other seepages developed during that period the mat and spilled cement covering the floor were removed and the shaft, over half its section, was deepened to the footwall of the seam. Reinforced concrete walls were poured, the remaining half of the section was blasted away, and walling of the shaft was completed.

It was found advisable not to dig into the massive lavas underlying the seam until after the collar was brought down to that level. The concrete walls were later on extended 4 ft below the seam, definitely keeping away outside waters from shaft excavation.

While the seam was becoming exposed, three limited flows of clear water developed, respectively located in the southeast, southwest, and northwest corners of the shaft. They were easily taken care of by inserting bleeding pipes into the wet fissures and by grouting through these pipes as soon as the concrete walls had sufficiently hardened.

Conclusions

Discharging the maximum amount of clay from a seam and replacing it with a bulky mixture of cement and sawdust proved the practical method for grouting a mud seam. It is likely that the amount of cement that had already been pumped in helped solve the problem, but time and money would probably have been saved by applying the cement-sawdust filling method as soon as clay was detected in the seam.

Acknowledgments

The authors wish to thank Vendome Mines Ltd. and Patrick Harrison & Co. Ltd. for permission to publish this paper. Appreciation is also expressed to the crew who at times had to work under severe conditions.

Air Handling and Dust Control In Johns-Manville's New Asbestos Mill

by J. Goldfield

ASBESTOS fiber, before it can be used commercially, is separated from the rock in which it is naturally found. Johns-Manville Corp. is currently constructing a 12-story fiber mill, of which the first half is completed and in operation. The mill will be the largest in the world, producing about 30 pct of the world's fiber. It was engineered and constructed by a cooperative effort of the engineers of the Canadian Johns-Manville Fibre Div. and the general plant engineering dept. Detailed design work on all phases of the job was done by Surveyer, Ninniger & Chenevert of Montreal.

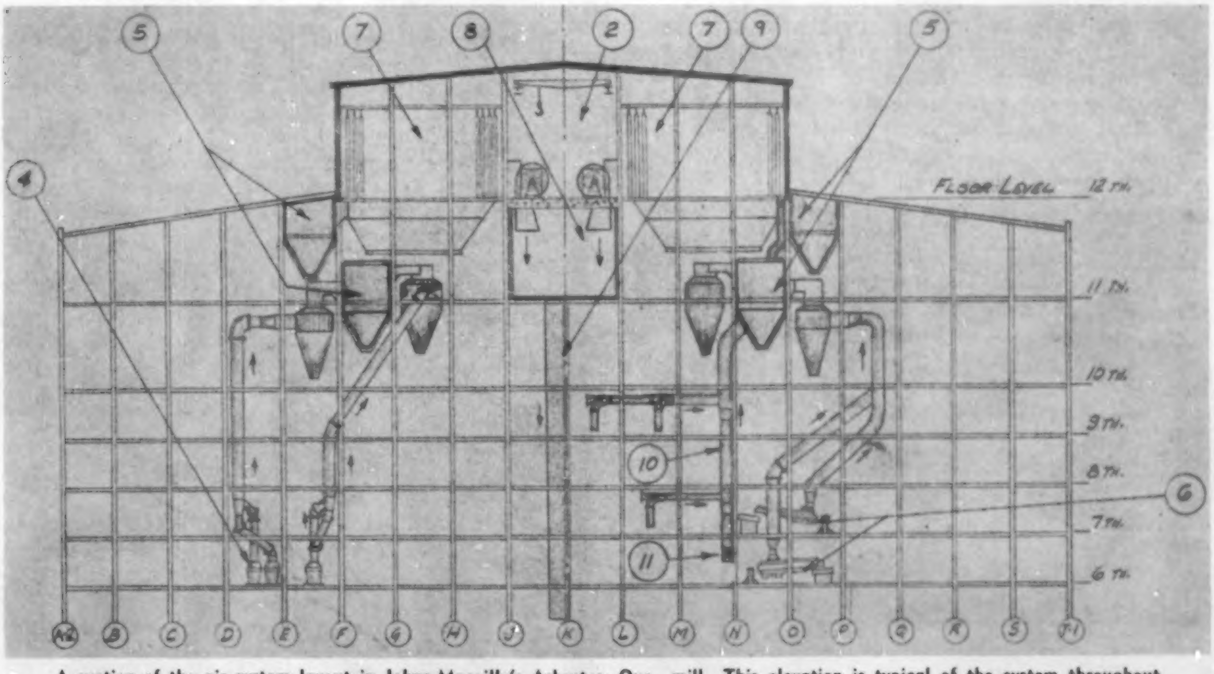
A series of crushing, screening, air aspirating and air separating processes will separate the fiber from 10 tons of rock per min. But to process this amount of ore about 90 tons of air per min will be handled in the aspirating and dust-collecting systems. To express this in more common units, 2.5 million cfm of air will be required. All this air will pass through a bag-type continuous automatic filter and will be expelled to atmosphere in summer or returned to the mill for heating during the winter months.

The air handling installation is made up of numerous fiber aspirating, fiber collecting, and dust collecting systems each consisting of hoods, duct work, and cyclones. The entire system is made up of these individual systems plus a set of fans and bag collectors and plenums common to all individual systems. The first portion of this unique installation, handling 1.3 million cfm, is now in successful operation.

J. GOLDFIELD is Dust Engineer, Johns-Manville Corp., General Plant Engineering Dept., Engineering Center, Manville, N. J.

The entire 12th floor (112x432 ft) which houses the fans and collectors is a leak-tight chamber. The roof is a concrete slab, the walls are 10-gage steel plate continuously welded to the building steel, and the portion of the floor not covered by the bag collectors is of concrete or welded steel plate. The roof and walls are properly insulated to prevent condensation. In fact the entire 12th floor can be considered a large plenum chamber with the fans as well as the bags inside.

Since the fans must induce flow through long runs of duct work, cyclones, plenum chambers, and bag collectors in a system extending through all floors of the building, the negative pressure required in the fan room is now 7.5 in. of water. At this pressure, it is impossible to open a door into the fan room. Air locks have been provided to allow entry during normal operation of the system. The air lock consists of a small welded steel chamber with a door to the fan room and a door to the building outside the fan room. By manipulating leak-tight butterfly valves mounted in the doors, the air lock pressure



A section of the air system layout in Johns-Manville's Asbestos, Que., mill. This elevation is typical of the system throughout the building. 1 (not shown)—Air lock. 2—Fan room. 3—Elevator. 4—Separators. 5—Dirty air plenums. 6—Screens. 7—Collector. 8—Clean air plenum. 9—Return air duct. 10—Dust riser. 11—Rotary valve.

A view of the first half of the new mill at Asbestos, Que.

may be equalized with either the fan room or the rest of the building.

Bag Collector

The collector will have 48 compartments each containing 1200 bags about 5 in. diam and 14 ft long. Each compartment contains about 24,000 sq ft of cloth for a total of 1.123 million sq ft—more than 25 acres of fabric!

The bag collector parts including cell plate floors, bags, and shaking mechanism were manufactured by the American Wheelabrator & Equipment Corp. Hoppers, screw conveyors, control systems, and the leak-tight enclosure of the 12th floor were designed and constructed by Johns-Manville Corp. engineers or under their supervision.

Fans and bag collector at the Asbestos mill. All fans and filters are located on one floor.

There is a hopper below each compartment for catching the dust, which is removed by a ribbon screw conveyor, dropped through a rotary valve, and carried away by a high pressure pneumatic conveying system. The air enters in one end of the hopper through a 4x10-ft single leaf butterfly damper. The damper closes off the air flow (about 60,000 cfm) when the compartment bags are shaken.

Unlike most bag collector installations, this one is integrated into and supported by the building steel. There are no leak-tight partitions between the compartments or between the bags and the fans. However, the most unique feature is the arrangement whereby the large dampers are placed on the *dirty* air side of the filter instead of the clean air side, as is far more common with a continuous automatic filter that is under vacuum. By this innovation approximately 80,000 sq ft of leak-tight steel partitions have been eliminated, and it is possible for the operator to maintain or repair any part of the bag collector or fans without shutting the system down. As an added advantage, it is estimated that 1 to 2 in. of pressure loss have been eliminated by doing away with the conventional type of fan connections to bag collectors.

The size of the installation may be appreciated by examining the picture on page 1031 that shows the operators standing at the central control panel for the 12th floor. Since it is impossible economically to design and build an installation of this size so that it is leak-tight, placing the bag collector under negative pressure avoids leaking air, which would create an intolerably dusty condition in the mill, and also permits handling clean air with fans that are more economical, more efficient, and more easily maintained. These fans can be bought with limiting horsepower characteristics.

In most of the small bag collector installations, manometers reading pressure drop across the cloth bags are used to determine the condition of the cloth and efficiency of shaking mechanisms. Since the bag collector compartments are connected to a common dirty air plenum on one side and the 12th floor on the clean air side, manometers connected across individual compartments would read the difference in plenum pressures irrespective of the condition of the cloth. They would be practically useless for determining whether the bags were being properly shaken. Therefore a trouble annunciator system has been incorporated into the installation controls. Numerous types of mechanical trouble that would interfere with proper shaking of the cloth bags cause a horn to blow and numbers to drop on an annunciator indicating the type of difficulty and the approximate location.

Leakage of air through the air inlet dampers to the bag collector, when the dampers are supposed to be closed, could reduce the effectiveness of the shaking cycle and cause an increased bag pressure drop. To discover this trouble if it occurs, sensitive manometers reading a maximum of 0.20 in. of water are connected across the bags of each compartment. Ordinarily these manometers read about 0.010 in. of water when the inlet air dampers are closed. An increase in air leakage for any reason, such as improper seating of the damper, will immediately show up in the manometer reading.

A flexible control system for automatically shaking the bag collector compartments is provided. The compartment to be shaken is selected by a standard type of program controller. The large inlet damper in the end of the hopper below closes and starts the four motors that shake the bags in a compartment. The shaking time is controlled by a timer that can be adjusted to any selected interval. After the shaking interval, a *settle* timer controls the interval between the end of a bag shaking period and the reopening of the inlet air damper. A third timer is used to control the interval between the opening of the inlet damper and the selection of the next compartment for shaking. Thus with a minimum of difficulty the shaking cycle may be changed for the six control groups into which the 48-compartment bag collector is divided for shaking purposes.

In operation, the air coming from the bag collector is quite clean. Dust samples taken with Greenberg-Smith impingers and counted by standard microscope techniques gave results of 140,000 particles per cu ft of air—an extremely low figure. There were almost no recognizable asbestos fibers in the samples.

Fans

Heart of the air installation is the group of eighteen 350-hp fans, which create the pressure differences required to move 2.5 million cfm through all the mill air systems. The fans are of the latest type, the airfoil blades combining high efficiency with other desirable characteristics associated with backward-curved fans—for example, limiting horsepower characteristics. The fans were manufactured by B. F. Sturtevant Co. of Canada Ltd., a division of Canadian Westinghouse. This company cooperated with Johns-Manville Corp. engineers in running a full-scale, full-power witness test.

Because of their size, individual fans are directly connected to the fan motors by means of flexible couplings. This decision was made despite the advantages of a drive that would not permit fan speed changes to be made.

For the following reasons, each fan is equipped with inlet vanes:

1) Vanes may be used to start the fan under relatively small load. They are kept closed during starting of all the fans, thus saving some power.

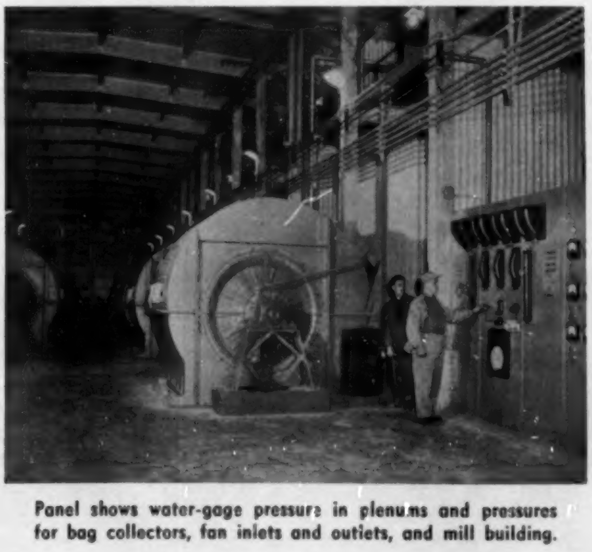
2) Inlet vanes are used for automatic pressure regulation.

3) In case of motor failures vanes are arranged to close automatically, preventing considerable flow of air back through the stationary fan rotor.

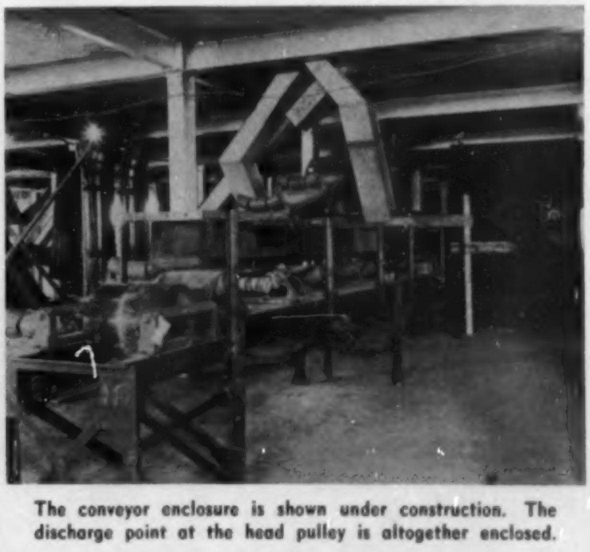
4) Vanes are used to improve the system efficiency. Fan efficiency is increased by partially closing inlet vanes when fans operate off the peak of the efficiency curve.

The fan inlet vanes are automatically controlled by compressed air operated cylinders. Setting of inlet vanes is determined by the pressure of the dirty air plenum. Pressure at which the dirty air plenums shall operate is set from the control panel. After it is once set, the vanes are automatically moved so as to maintain a constant dirty air plenum pressure. The vanes may be held closed until all fans are started and then opened simultaneously from the central control panel.

Fan starting switches, ammeters for fan motors, gages reading the various plenum pressures, gages



Panel shows water-gage pressure in plenums and pressures for bag collectors, fan inlets and outlets, and mill building.



The conveyor enclosure is shown under construction. The discharge point at the head pulley is altogether enclosed.

reading bag collector pressure drop, and annunciators are located on the central control panel. From this central point the entire system may be controlled and its operation checked.

Each fan is equipped with an expanding outlet section to regain static pressure and conserve power. The expanding outlet is fitted with leak-tight doors that may be closed manually when it is desired to make major repairs. The doors are provided to prevent large air flow back through the fan up into the 12th floor enclosure.

Dirty Air Plenums

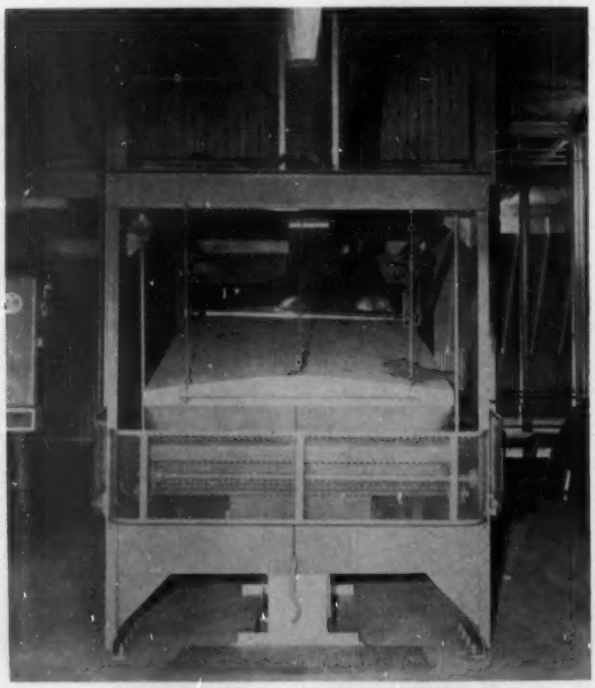
Large plenum chambers have been installed before the bag collector. They have three functions: 1) to serve as a manifold for the many fiber and dust collecting systems, 2) to precipitate rock and fiber that pass out through cyclones when the cyclones block, and 3) to act as a manifold on the dirty air side of the bag collector so that air flow is redistributed to the bag collector when a compartment damper closes to allow shaking.

Due to the requirements of the layout, dirty air plenums are required on two sides of the building. They run almost the entire length of the mill. Material dropped out in the plenums is carried away by button conveyors and discharged through rotary valves.

Clean Air Plenums

There will be an electrical power load of about 10,000 kw in the entire mill. This represents a release of energy equivalent to 34,000 lb of steam per hr. Since practically all this energy is released as heat into the mill building, a problem and a possibility present themselves. The problem is to discharge the heat in summer. The possibility is to use this energy to heat the mill in winter.

If all the air used in fiber handling and dust control (2.5 million cfm) were discharged to the outdoors, the electrical energy could only maintain the mill at about 15° above outdoors. Since temperatures of −20°F are not uncommon, it would take an additional 150,000 lb of steam per hr to maintain the mill at a reasonable temperature under these conditions. On the other hand, if the air is recirculated, comfortable temperature will be maintained without auxiliary heating.



Screens are the greatest source of dust. A typical screen cover of lightweight aluminum is shown here.

A system of clean air plenums and return ducts permits recirculation of air in winter and expulsion of air in summer. In summer the air is discharged to the outside through louvered openings in the end of the plenums.

Constant checks are being made to insure that dust counts from the bag collector do not build up. Based on partial system operation during the winter of 1954 to 1955 comfortable temperatures were maintained throughout the mill building.

Cyclones

Almost 200 cyclone collectors of various sizes are required for the fiber handling and dust control systems. Considerable engineering and design effort went into the development of cyclone collectors of minimum pressure drop and efficiency high enough to collect asbestos fibers of commercial value. The cyclones developed through this effort collect fiber as well as previous designs and have about 2.5 in. of water less pressure loss. To minimize maintenance due to abrasion, many of the cyclones have been rubber-lined.

Literally miles of large-diameter sheet steel piping have been installed to convey the asbestos fiber and to control dust. The material conveying pipes are all welded heavy gage sheet steel. Many elbows have been rubber-lined to resist abrasion.

Dust Control

The milling of asbestos fiber is a dry process. As such it is quite dusty, and a great deal of effort and money has been devoted to controlling this dust. In the early stages dusty machines and processes were carefully redesigned in attempts to enclose the dust and keep it from working areas. In addition, about 500,000 cfm of air have been set aside for dust control purposes in the full mill.

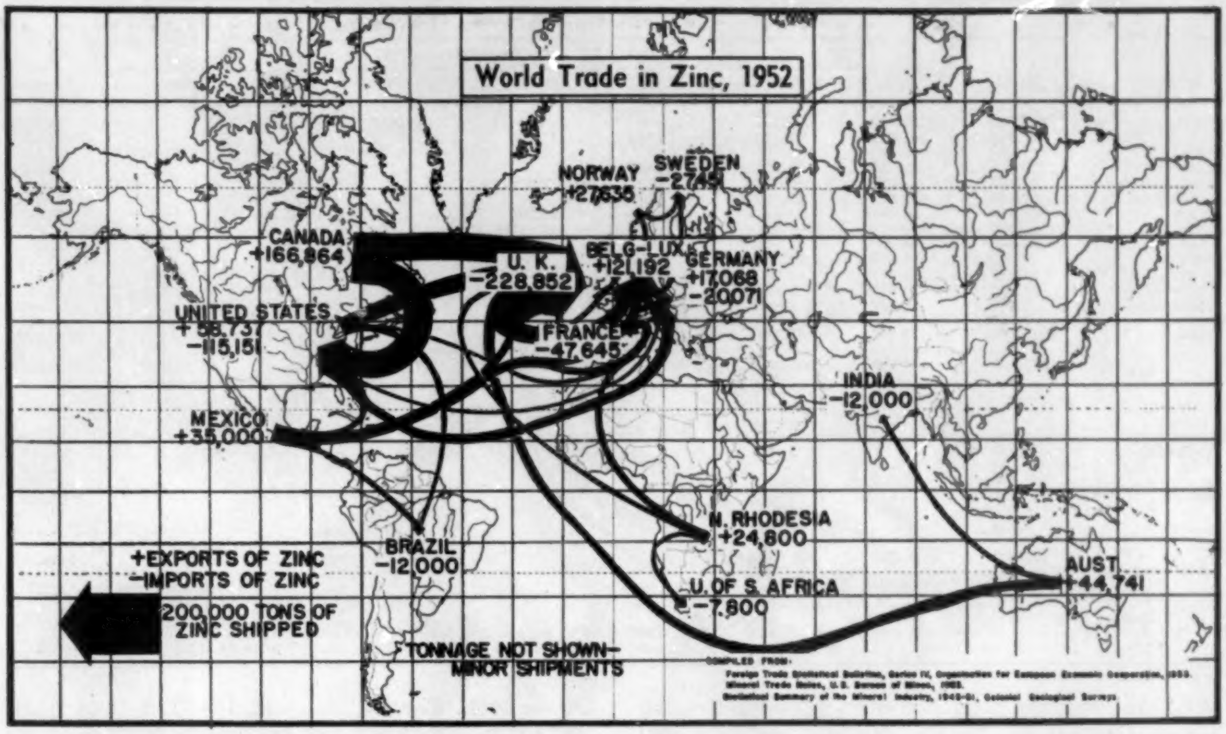
All the hundreds of oscillating screens have been provided with dust covers of a type developed by Johns-Manville's asbestos mine. They confine dust yet allow easy screen inspection and maintenance. About half the screen covers have been fitted with exhaust connections.

About one third to one half of the many thousands of feet of belt conveyors have been covered with a tight-fitting enclosure and exhaust connections added to strategic points. Crushers, packers, rotating screens, and elevators—all points where dust might escape to the mill atmosphere—have been provided with exhaust air.

To facilitate handling the large air volumes required for dust control and to allow additional connections in the future, 18 large risers are planned for the full mill. These risers are practically vertical and have considerable reserve capacity. On each floor dust control systems are added or may be added in the future.

Because of the reserve capacity, sections of the risers do not have adequate air velocity to carry the dust. At the base of each one a rotary valve discharges material to appropriate belt conveyors.

Results in the first portion of the mill have been gratifying. The new asbestos mill at Johns-Manville's Jeffrey mine is one of the cleanest in the asbestos mining and milling industry.



INTERNATIONAL MINERAL TRADE SERIES Part VII

World Trade in Zinc Metal and Concentrates

by John D. Ridge and Robert C. Barwick

IN contrast to international trade in lead, a much larger percentage of zinc shipped from one country to another is shipped in concentrate form. In 1952 international commerce in zinc concentrates accounted for 37 pct of world zinc mine production, and of the total zinc which traveled from one country to another, slightly more than 65 pct was in concentrates. The comparable figures for lead, given in Part VI, were 16 and 27 pct. Of the zinc mined in the world in 1952, 56.6 pct entered international trade; the analogous figure for lead was 57.4. This similarity in proportion of production traded is paralleled by a similarity in sources of exports. The three leading exporters of zinc in all forms in 1952 were Canada, Mexico, and Australia, in that order; the three largest exporters of lead were Mexico, Australia, and Canada.

In contrast to the 86 pct theoretical maximum in lead concentrates, the maximum for zinc concentrate is only 67 pct. On this basis alone, it would be reasonable to expect that more zinc would be traded as zinc metal than lead as lead metal. Actually, the reverse is true. Less than 28 pct of the lead in international commerce moves as lead in concentrates, while 65 pct of the zinc so traded is as concentrates. Mexico, a country which has attempted to retain as much metal processing activity as possible within its own borders, has negligible exports of lead in concentrates. This is not true of zinc, for about 85 pct of Mexican zinc exports leave the country as a concentrate. To a large extent this anomalous situation is due to the greater size of plant and expenditure of capital required in the modern horizontal retort method of zinc smelting than for lead smelting; this tends to attract zinc concentrates to already existing zinc smelters rather than capital to the sources of zinc concentrates. It appears probable, however, that it will not be many years until zinc smelting capacity in producer countries is greatly increased and trade in zinc in concentrates largely reduced.

JOHN D. RIDGE is Assistant Dean, College of Mineral Industries, and Head of the Dept. of Mineral Economics, Pennsylvania State University, University Park, Pa. ROBERT C. BARWICK is a Graduate Assistant in Mineral Economics, Pennsylvania State University.

In 1952 (see Table X) the U. S. was the world's largest importer of zinc in concentrates, with more than 48 pct of total world trade. The only other important importer was Belgium, with 25 pct of all exports. The United Kingdom and France were moderately large importers of zinc in concentrates, with nearly 11 and 10 pct respectively, and Norway and Germany received minor amounts between 3.5 and 4 pct. The U. S. obtained concentrates from every continent but Asia, Mexico and Canada having been the major suppliers and Peru, Spain, and Bolivia following, in that order. In all, nine countries provided the U. S. with 2400 tons or more of zinc in concentrates.

Belgium-Luxemburg got its zinc in concentrates in gradually diminishing quantities from ten countries, of which the Belgium Congo, Peru, and Australia were the largest suppliers. The major source of United Kingdom zinc concentrates was Australia, with appreciable contributions from Canada and with a little from Mexico. France obtained zinc concentrates mainly from French Africa and Spain, but Peru, Canada, and Italy were important con-

Table X. Zinc Concentrates, Tons, 1952

Exporter	Total	Importer: U. S.	Belg.-Lux.	U. K.	France	Germany	Norway	Misc.	Europe
Mexico	205,000	199,745	2,797	—	—	2,151	—	—	(5,000)
Canada	181,745	148,970	7,190	13,544	11,797	—	—	—	(32,500)
Peru	111,444	44,401	42,000	—	16,250	—	—	8,000	(58,500)
Australia	111,000	2,398	30,000	78,600	—	—	—	—	(108,500)
Belg. Congo	74,091	—	52,603	—	4,522	—	17,000§	—	(74,000)
Sweden	47,162	—	27,635	—	—	5,591	12,733	1,200	(46,000)
Spain	46,500	16,647	—	—	23,220	—	5,160	1,600	(28,500)
Italy	40,000	—	—	—	10,017	20,000	—	10,000	(30,000)
Fr. Africa	39,606*	—	12,504**	—	24,122	—	—	3,000	(36,500)
Bolivia	33,581	14,418	13,800	2,000	—	3,200	—	—	(19,000)
U. of S. Af.***	14,000	4,917	5,000	2,000	—	—	—	2,100	(7,000)
Yugoslavia	13,500	2,512‡	3,700	—	—	2,600	—	4,700	(6,300)
Guatemala	9,989	9,989	—	—	—	—	—	—	—
Austria	3,830	—	—	—	—	3,830†	—	—	(3,830)
Europe	(150,992)	(16,647)	(31,335)	—	(33,237)	(32,021)	(17,900)	—	(131,000)
	931,457	448,699	233,000	101,100	90,000	37,372	34,900	20,600	(548,600)
1932			Japan						
Canada	56,000	—	—						56,000
Australia	29,000	—	8,000						21,000
India	24,000	—	—						24,000
Mexico	23,000	2,000	—						21,000
Bolivia	11,000	—	—						11,000
Asia	8,000	—	5,000						3,000
Russia	8,000	—	2,000						6,000
	159,000	2,000	15,000						146,000

U. S. production in 1952 — 666,001 tons.
* Fr. Morocco 31,903, Algeria 6,634, Fr. Eq. Africa 1,069.
** From Fr. Morocco.
*** An additional 8,500 tons was exported from S.W. Africa, 4,500 tons to Belg.-Lux., 1,800 tons each to U.S. and U.K.
† May be in part re-exported. ‡ Yugoslavia reports 6,715 tons shipped to U.S. § Originally exported to Belg.-Lux. and re-exports.

tributors. Norway depended mainly on the Belgian Congo, Sweden, and Spain, and Germany depended on Italy, with a small amount from Sweden and several other countries.

Thirteen countries in 1952 exported 10,000 tons or more of zinc in concentrates, the largest amount, 205,000 tons, coming from Mexico; the next in order of exports was Canada with 182,000 tons, followed by Peru with 111,500 tons, and Australia with 111,000. The remaining eight range from the Belgian Congo with 74,000 tons to Guatamala with 10,000.

The first two U. S. suppliers are directly contiguous south and north of this country, respectively, and two of the next three are in western South America. As a result, the U. S. is in danger of interruption of its zinc concentrate imports only if large-scale invasion occurs.

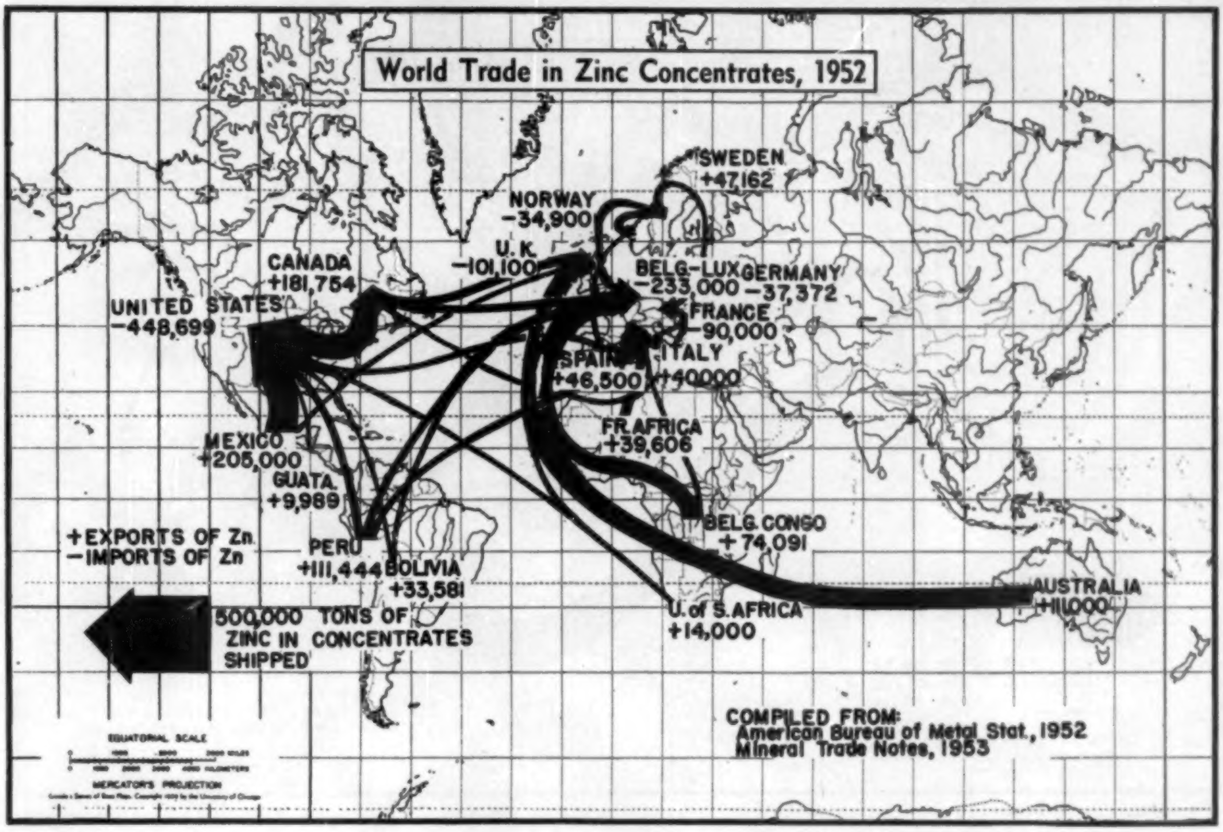
ALTHOUGH 65 pct of 1952 world zinc trade was in concentrates, the 35 pct which traveled as metal was an impressive 495,500 tons, see Table XI. Of the total, Canada, Belgium, the U. S., and Australia exported 79 pct, and nearly half of all exports, 46 pct, went to the United Kingdom, with 23 pct going to the U. S. and minor amounts going to six countries on four continents. The United Kingdom obtained its zinc metal principally from Canada, Australia, the U. S., and Belgium. The U. S. received most of its zinc metal from Canada. Mexico, Belgium, and Germany also exported considerable amounts to the U. S., and still smaller amounts came from Italy, the Netherlands, and Yugoslavia. The U. S., in turn, exported zinc to slightly more than half of the amount of its imports, mainly to the United Kingdom, with small tonnages to Brazil, France, India, and Germany.

France got its zinc metal in large part from Belgium with some help from the U. S., Northern Rhodesia, and Germany; India from five countries in almost equal amounts; and Germany principally from Belgium and the Netherlands. Germany re-exported almost as much as it imported, the exports

Table XI. Zinc Metal, Tons, 1952

Exporter	Total	Importer: U.K.*	U. S.	France	Sweden	Germany**	India	Brazil	U. of S.A.	Misc.	Europe
Canada	166,864	77,100	69,722	3,372	—	—	2,681	—	—	13,000	(80,500)
Belg.-Lux.***	121,192	36,980	6,854	20,708	12,219	10,864	2,806	1,814	—	31,000	(81,000)
U. S.	58,737	40,500	—	5,563	—	2,000	2,036	4,000	—	3,500	(49,000)
Australia	44,741	41,070	—	—	—	—	2,400	—	—	1,000	(41,000)
Mexico	35,000	—	18,686	2,213	—	—	—	5,000	—	9,000	(2,500)
Norway	27,635	12,440	—	2,550	11,942	—	—	—	—	500	(27,000)
N. Rhodesia	24,800	10,231	1,064	6,664	—	—	1,904	—	7,800	—	(17,000)
Germany	17,068	2,800	7,068	5,515	—	—	—	—	—	1,500	(8,500)
Europe	(165,895)	(52,220)	(13,922)	(28,833)	(24,161)	(2,806)	(10,864)	(1,814)	—	—	(135,000)
	495,445	228,852	115,151†	47,645	27,451	20,071*	12,000	12,000	7,800	59,500	(443,500)
1932		Asia	Japan	Russia					Africa		
Canada	80,000	1,000	14,000	—			4,000	1,000	—		60,000
Mexico	45,000	—	—	—			—	—	—		45,000
Australia	38,000	—	8,000	—			4,000	—	—		26,000
Europe	27,000	2,000	—	11,000			7,000	4,000	3,000		—
U. S.	6,000	—	3,000	—			1,000	—	—		2,000
	196,000	3,000	25,000	11,000			16,000	5,000	3,000		131,000

U. S. production for 1952 — 575,828 tons.
* Including 7,355 tons from the Netherlands.
** Plus 3,000 tons from Yugoslavia.
*** Including 4,774 tons to the Netherlands.
† Including 2,788 tons from Yugoslavia and 3,976 tons from the Netherlands.



going to the U. S. and France. The Union of South Africa imported nearly 8000 tons from Northern Rhodesia, much of which was almost certainly re-exported. Brazil received 5000 tons from Mexico and lesser amounts from the U. S. and Belgium.

Canada was the principal exporter of metallic zinc, its exports going to the United Kingdom and the U. S. Belgium sent zinc to the U. K., France Sweden, Germany, and the U. S. Mexico supplied several countries, of which the U. S., Brazil, and France were most important.

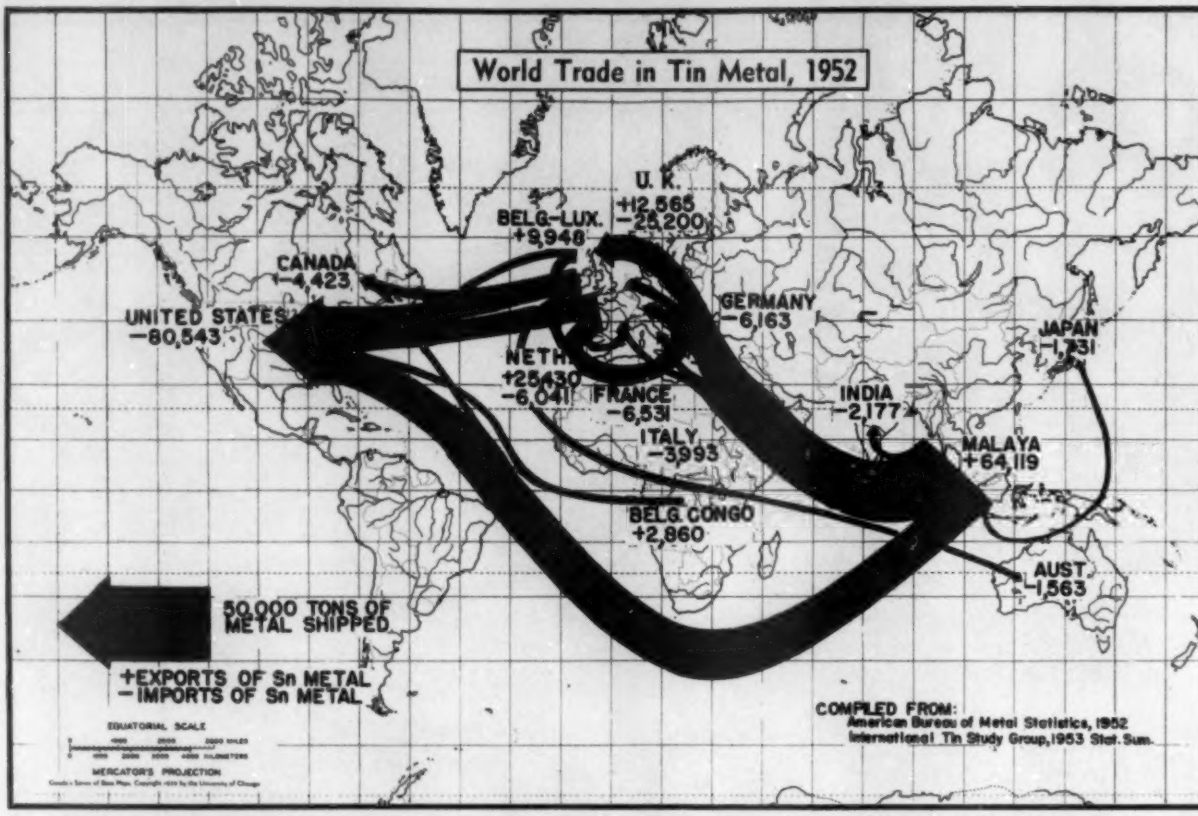
The U. S. position in zinc metal shows dependence on the same main sources that supplied zinc in concentrates—Canada and Mexico—so no matter what the political events of the future may be, an adequate supply seems assured.

Part VIII World Trade in Tin Metal and Concentrates

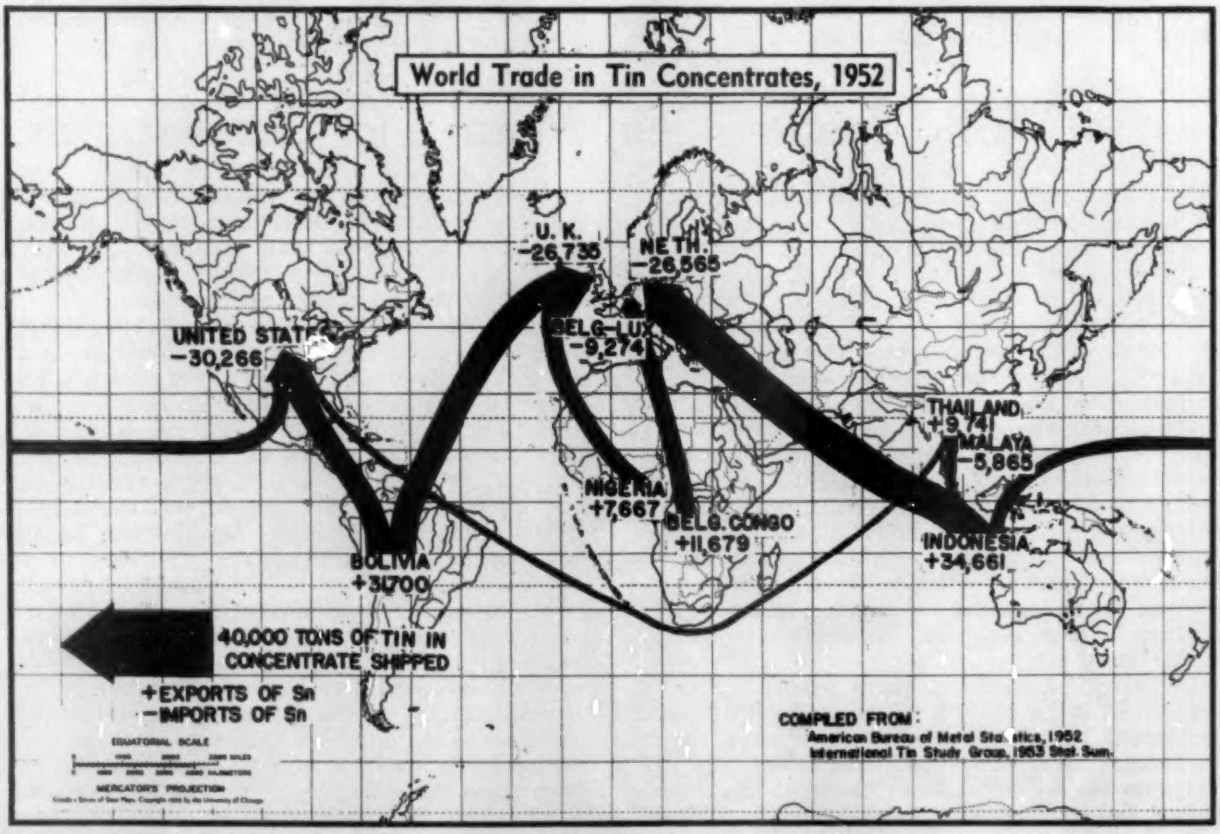
THE amount of tin produced and moving in international trade is much smaller than that of any one of the nonferrous metals already discussed. During 1952 nearly 100,000 tons of tin in concentrates were shipped to smelting countries, see Table XII. These mining countries also sent about 60,000 tons of refined metal to other countries, as shown in Table XIII. This means that the total tin in international trade was about 160,000 tons. The totals of tin in concentrates and tin in metal shipped abroad, however, exceeded 210,000 tons, indicating that some 50,000 tons were refined in countries that did not use it or were shipped into a given country as metal and shipped out again in the same form. Additional tonnages of imports were not consumed in the importing country but were added to Government and industrial stockpiles; production of tin metal in 1952 appears to have exceeded consumption by nearly 40,000 tons.

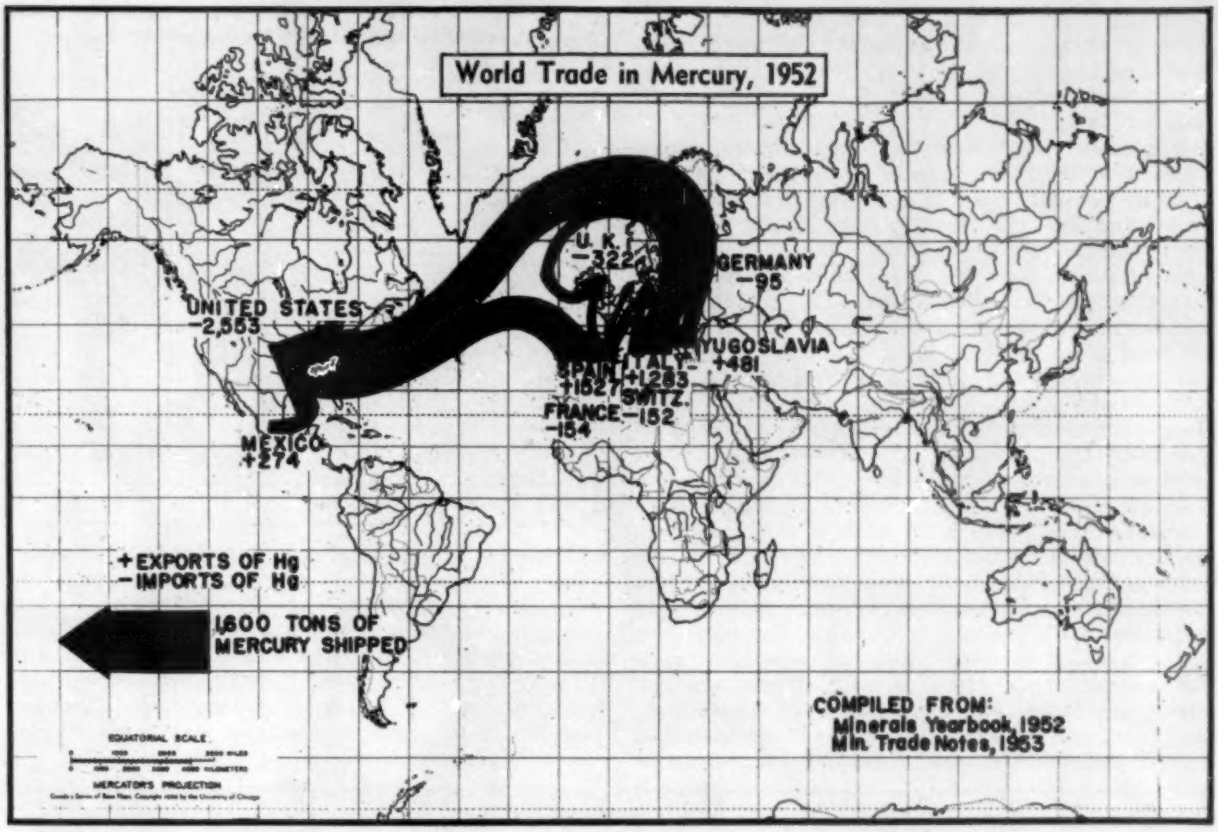
Because of unequal and sparse distribution of tin deposits in the world, tin mining and smelting are concentrated in a relatively few countries, although tin is used throughout the world. Thus only five countries are important exporters of tin in concentrates—Indonesia, Bolivia, the Belgian Congo, Thailand, and Nigeria. Of the total tin in concentrates exported in 1952, Indonesia and Bolivia provided almost two thirds of the tin in concentrates in world trade; each of the other three principal exports accounted for about one ninth of the total.

As only five countries now have large tin smelting and refining facilities in operation, trade in tin in concentrates flows in rather restricted channels. The three largest importing countries in 1952, the U. S., the United Kingdom, and the Netherlands, received 85 pct of the total exports, the remainder going to Belgium and Malaya. The U. S. got its concentrates from Bolivia, Indonesia, Thailand, and the Belgian Congo, about half the supply coming from Bolivia and a quarter from Indonesia. The U. K. depended on Bolivia (two thirds) and Nigeria (one third) for its concentrates, and the Netherlands received its supply almost entirely from Indonesia—another example of politico-economic ties surviving the breaking down of political relationship. Belgium got all its concentrates from the Belgian Congo, and Malaya almost all its imports from Thailand. The huge production of tin ore in Malaya, of course, enables the large smelters in that country to operate with a minimum of help from abroad.



In Malaya, where the tin reserves are large, concentrates are of high grade and labor is cheap; about one half the tin content of the ore mined there was smelted and refined locally. In Indonesia and Bolivia little smelting is done, but for somewhat different reasons. The average Bolivian tin concentrate requires complex treatment, and former owners of the Bolivian ores have preferred to smelt and refine in the U. K. where fuel and skilled labor are readily available rather than in Bolivia where they are lacking. Indonesian concentrates are of quite high grade and a domestic smelting industry could operate once the necessary plants were built. The Dutch, possibly seeing the handwriting on the wall, established their main smelter at Arnhem in the Netherlands, and the World War II damage to the one sizable smelter built

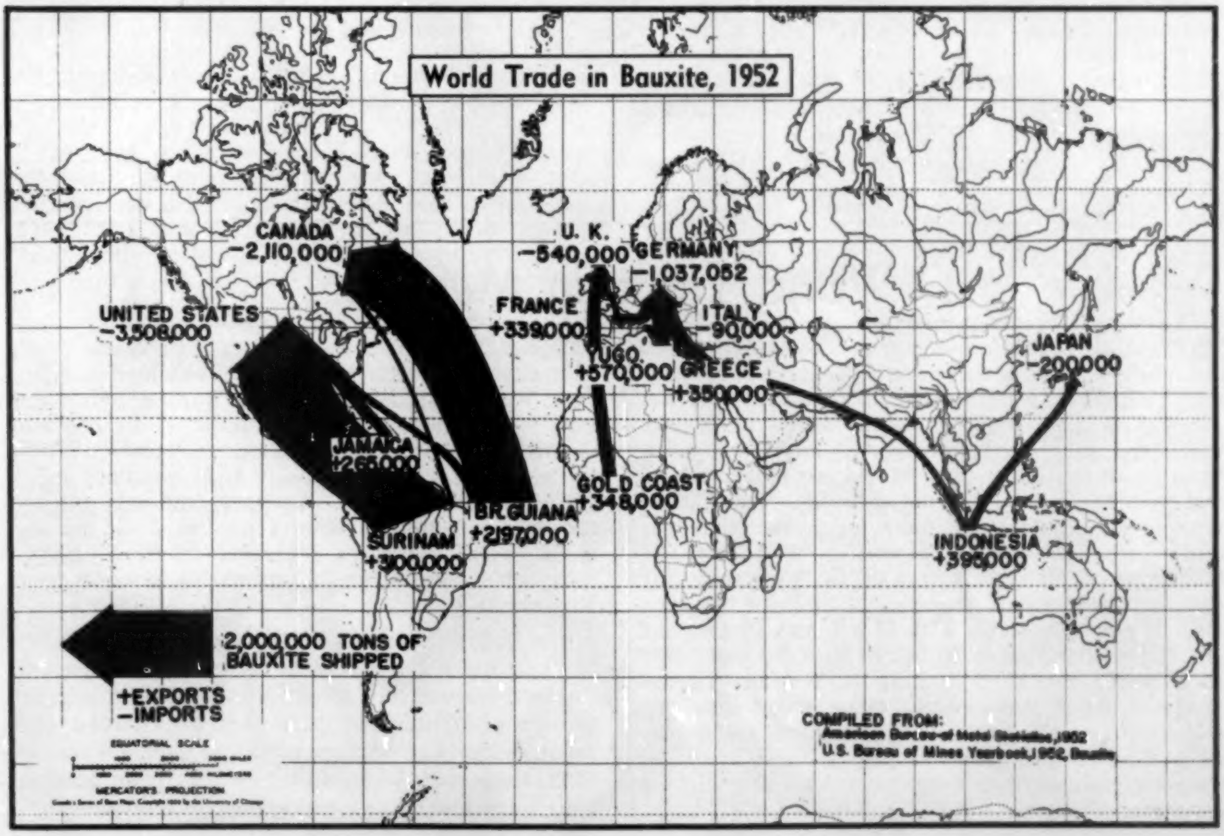




in Indonesia prior to the war was never repaired. Nigerian reserves have never justified any large-scale smelter construction, and Thailand is too close to Malaya and under too much pressure from the U. S. to supply high grade concentrates for the Texas City smelter to have done anything about local smelting of tin.

Tin Metal

Some 115,000 tons of tin metal were exported in 1952. Essentially no tin was exported by the U. S., so the bulk of this tonnage came from the other four major smelting countries, with a little help from the Belgian Congo, which has not been an important producer of tin metal since the end of World War II.



Over half the total exports were sent abroad from Malaya, while some 22 pct came from the Netherlands and 11 pct from the U. K. The remainder came chiefly from Belgium, with a small fraction from the Belgian Congo.

In contrast to the trade pattern of tin in concentrates, ten countries imported more than 1500 tons of tin metal in 1952, the U. S. holding first place with 70 pct and the U. K. trailing with 22 pct, of which about one half was re-exported. The U. S. obtained most of its tin from Malaya, but with appreciable help from the Netherlands, the U. K., and Belgium, and a small amount from the Congo. The U. K. also got most of its tin from Malaya, about one tenth of its imports coming from the Netherlands. The Netherlands provided the main supply for both France and Germany, although both received sizable quantities from Malaya. The Netherlands in turn received most of its imports from Malaya, with some from the U. K.; the Dutch, however, exported more than four times as much tin metal as they imported. Malaya was also the principal source of tin for Canada, Italy, India, and Japan, although Australia depended mainly on the U. K. to supplement domestic production.

The position of the U. S. with regard to tin is worse than for any other of the nonferrous metals already discussed. The Texas City smelter can operate on Bolivian concentrates alone, but the operation is much more efficient and productive if these can be blended with high grade concentrates from southeast Asia. Obviously, our access to these sources is uncertain, and complete U. S. dependence on Bolivia can be brought about in a matter of days. As all other smelting countries except Belgium depend largely or entirely on Far Eastern concentrate sources, the U. S. could not depend on its European sources of tin metal if southeast Asia were to pass into Communist hands.

Table XII. World Trade in Tin Concentrates, Tons

		Importer					
Exporter	Total	U. S.	U. K.	Netherlands	Belg.-Lux.	Malaya	Europe
1952							
Indonesia	34,601	8,106	—	26,458	—	—	(26,458)
Bolivia	31,702	15,379	16,236	—	—	—	(16,236)
Belg. Congo	11,679	1,192	—	—	9,274	—	(9,274)
Thailand	9,741	4,677	—	—	—	4,650	—
Nigeria	7,667	—	7,667	—	—	—	(7,667)
	95,390	26,735	26,565	30,366	9,274	5,865	(59,635)
1932							
Bolivia	20,900					—	20,900
Thailand	9,300					9,300	—
Indonesia	7,200					7,200	—
Nigeria	4,200					—	4,200
India	1,800					1,800	—
Indochina	1,100					1,100	—
Mexico	800					—	800
U. of S. A.	600					500	100
Japan	600					600	—
	47,500					20,500	27,000

U. S. Production 1952—100 Lt.

Table XIII. World Trade in Tin Metal, Tons

		Importer											
Exporter	Total	U. S.	U. K.	France	Germany	Netherlands	Canada	Italy	India	Japan	Australia	Misc.	Europe
1952													
Malaya	64,119	19,381*	16,298	2,617	1,335	4,725	1,530	3,993	2,015	1,731	—	10,500	(28,968)
Netherlands	25,430	16,861	1,880	3,500	2,780	—	514	—	—	—	—	—	(8,160)
U. K.	12,565	8,930	—	—	—	1,275	265	—	—	—	1,563	500	(1,275)
Belg.-Lux.	9,948	8,119	—	—	860	—	823	—	—	—	—	—	(860)
Belg. Congo**	2,860	1,448	—	—	—	—	—	—	—	—	—	1,400	—
Europe	(47,943)	(33,910)	(1,880)	(3,500)	(3,640)	(1,275)	(1,602)	—	—	—	(1,563)	—	(10,295)
	114,922	80,543	25,200	6,531	6,163	6,041	4,423	3,993	2,177	1,731	1,563	12,400	(39,263)
1932													
Malaya	48,700	22,100					—		2,400	2,300			20,900
Europe	11,300	8,700					200		—	—			—
Indonesia	8,200	700					—		—	—			7,500
India	5,100	—					—		—	—			5,100
China	4,900	3,900					—		—	1,000			—
U. S.	1,100	—					1,100		—	—			—
	80,100	35,400					1,300		2,400	3,300			34,200

U. S. Production for 1952—100 Lt (content of mined ore). * U. S. reports receiving 45,992 tons from Malaya. ** 1,112 tons to Belgium.

Part IX

World Trade in Mercury

BECAUSE smelting mercury is metallurgically so simple a process, there is no world trade in mercury (cinnabar) concentrates; all world trade in this element is done with the liquid metal itself. As there are only four exporters of any importance throughout the entire Free World, keeping track of the trade in mercury is not difficult, even though none of the exporters is famous for the completeness and accuracy of its mineral statistics. Spain was the leading exporter with 43 pct of the 3565 tons that entered international trade in 1952; Italy followed with 36 pct, Yugoslavia with 13 pct, and Mexico last with 8 pct. Principal importers of mercury, see Table XIV, were: the U. S., taking 72 pct; the United Kingdom, 9 pct; France and Switzerland, 4 pct each; and Germany, the Netherlands, Belgium, and Japan more than 13 tons each. A large number of countries received negligible amounts from the various exporters.

The U. S. received the bulk of the exports of all four exporting countries; the U. K. obtained mercury from each producing country in Europe, Spain and Italy supplying about equal amounts. France and Switzerland each imported about the same quantity, by far the most from Spain in both instances and a little from Yugoslavia. As Italy sent only minute amounts to countries other than the U. S. and the U. K., small importers depended chiefly on Spain, although several received appreciable amounts from Yugoslavia.

The U. S. obtained 90 pct of its imports of mercury from southern Europe, so any threat to that part of the world which might deny this country its present imports of mercury would have to be regarded with great seriousness. U. S. production, some 477 tons in 1952, could not, when added to that from Mexico, come anywhere near meeting current demand.

Table XIV. World Trade in Mercury Metal, Tons

Exporter	Total	U. S.	U. K.	Netherlands	Ger.	Belg.	Switz.	France	Japan	Hong Kong	Eur.	Afr.	S. A.
							Importer						
							1952						
Spain	1,527	936	157	45	62	27	133	129	13	—	(533)	—	—
Italy	1,283	1,055	141	—	—	—	—	—	—	—	(141)	—	—
Yugoslavia	481	307	24	16	33	—	19	25	—	—	(117)	—	—
Mexico	274	255	—	—	—	—	—	—	—	—	—	—	—
Europe	(3,291)	(2,296)	(322)	(61)	(95)	(27)	(152)	(154)	—	—	(838)	—	—
	3,565	2,553	322	61	95	27	152	154	13	—	(838)	—	—
							1932						
					India								
Europe	970	280			150				340	110	—	40	20
Mexico	240	—			—				—	—	240	—	—
Algeria	50	—			—				—	—	50	—	—
Bolivia	20	—			—				—	—	20	—	—
	1,280	280			150				340	110	310	40	20

Part X

World Trade in Bauxite

ALTHOUGH two producing countries, Surinam and British Guiana, dominated the world's trade in bauxite by exporting 41 pct and 29 pct of the 7,695,000 tons exported in 1952, six other countries exported over 50,000 tons in that year, as shown in Table XV. Surinam (Dutch Guiana) exported practically all its production to the U. S., sending very minor amounts to Canada and Germany. British Guiana, on the other hand, exported almost all it produced to Canada but did contribute something less than 200,000 tons to U. S. imports. As the next largest exporter, with 7.5 pct of the total exported, Yugoslavia was the main supplier for Germany and provided most of Italy's imports as well. Indonesia delivered half its exports to Japan and divided the rest among Germany, the U. S., and several other countries. Greece was Germany's second most important supplier and sent minor quantities to the U. K. and Norway. The Gold Coast exported only to the United Kingdom, but France sent bauxite to the U. K. and Germany and contributed slightly to Italy's and Norway's supplies. Jamaica sent all its production to the U. S., and French West Africa sent a small tonnage to Canada.

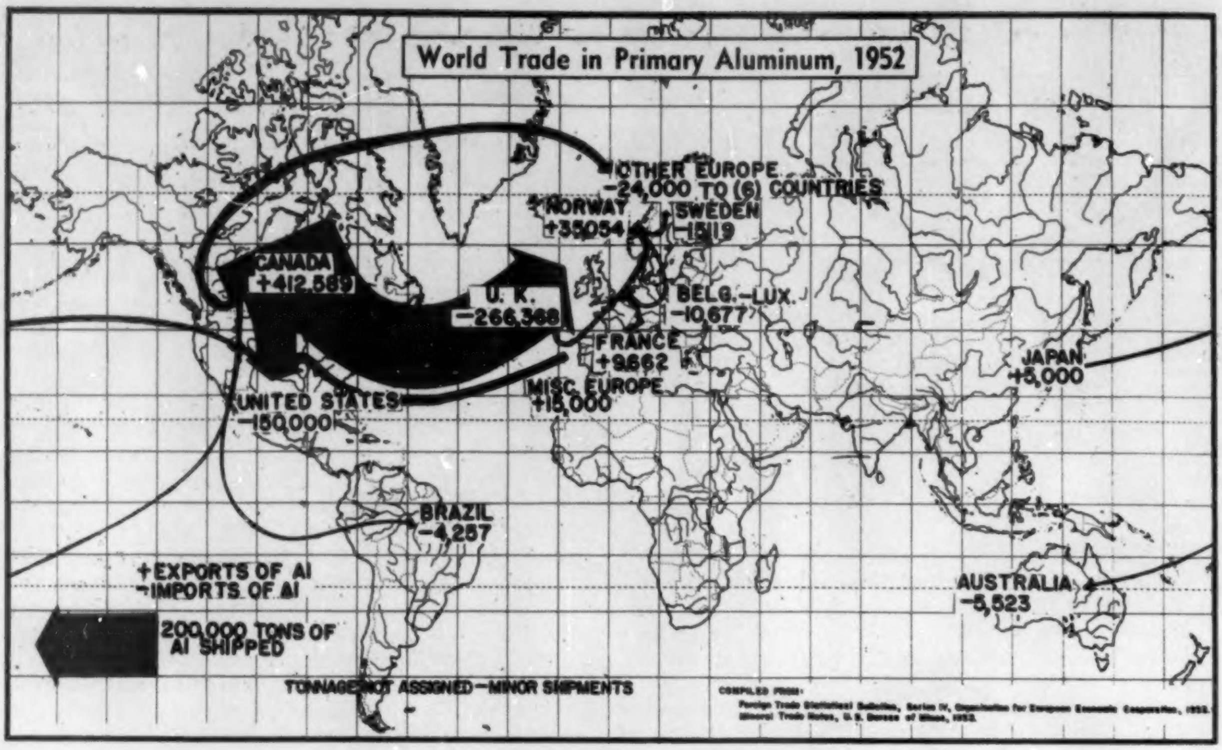
The U. S. got most of its imports from Surinam and relatively small amounts from Jamaica, British Guiana, and Indonesia. This last state had been a much larger supplier of the U. S. in the years immediately before 1952. Canada was supplied mainly by British Guiana, with small contributions from French West Africa and Surinam. Germany collected bauxite from several countries in much the same manner as she did with most of the other metal raw materials already discussed; these countries were Yugoslavia, Greece, France, Indonesia, and Surinam. The U. K. was furnished bauxite from the Gold Coast, France, and Greece, while Japan depended on Indonesia. Italy imported from Yugoslavia and France, and Norway from Greece and France.

The pattern of world trade in bauxite is one of countries with no capacity for producing aluminum sending this raw material to countries which have the electric power required to convert bauxite to alumina and alumina to aluminum. Not only must the country importing bauxite have the necessary energy to convert to electricity; it must also have skilled labor capable of building, operating, and maintaining the reduction plants needed for conversion of the oxide to the metal. Although the first aluminum plants were built where electric power already was being produced, plants at present are being constructed wherever water power is to be had in quantities sufficient for the tonnages of aluminum desired. The Aluminium Co. of Canada plant in the Nechako-Kemano-Kitimat area of British Columbia is an example of aluminum production where only the water power situation was originally favorable.

Table XV. World Trade in Bauxite*, Tons

Exporter	Total	U. S.	Canada	Germany	U. K.	Japan	Italy	Norway	Misc.	Europe
					Importer					
					1952					
Surinam	3,100,000	3,050,000	41,000	10,000	—	—	—	—	—	(10,000)
Br. Guiana	2,197,000	178,000	2,019,000	—	—	—	—	—	—	—
Yugoslavia	570,000	—	—	489,000	—	—	80,000	—	—	(570,000)
Indonesia	395,000	20,000	—	114,000	—	200,000	—	—	61,000	(114,000)
Greece	350,000	—	—	281,387	35,000	—	—	31,795	1,800	(348,182)
Gold Coast	348,000	—	—	—	348,000	—	—	—	—	(348,000)
France	339,000	—	—	117,000	157,000	—	10,000	3,411	51,600	(287,411)
Jamaica	265,000	265,000	—	—	—	—	—	—	—	—
Fr. W. Africa	50,000	—	50,000	—	—	—	—	—	—	—
Europe	(1,259,000)	—	—	(887,387)	(192,000)	—	(90,000)	(35,200)	(53,400)	(1,205,593)
	7,605,000	3,508,000	2,110,000	1,037,052	540,000	200,000	90,000	41,401	112,000	(1,677,593)
					1932					
Surinam	134,000	134,000	—							—
Br. Guiana	69,000	69,000	—							—
U. S.	58,000	—	54,000							4,000
Europe	45,000	6,000	31,000							—
	306,000	209,000	92,000							4,000

* Includes dried and calcined bauxite.



Part XI

World Trade in Aluminum

WELL over 7½ million tons of bauxite enter international trade, but only half a million tons of aluminum metal. This is primarily because bauxite, unlike tin concentrates, is mainly imported in amounts no greater than those needed as aluminum by the industries of the importing countries. The major exception to this rule is Canada, which imports more than 2 million tons of bauxite and sends out more than 400,000 tons of aluminum. Over 60 pct of this tonnage goes to the U. K. and some 30 pct to the U. S.; the rest goes in small quantities to widely scattered countries. Norway, the next largest exporter, sends out less than one tenth as much as Canada. All other exporters are of minor importance.

The U. S. and the U. K. are the only large importers of aluminum, although minor amounts are brought into Sweden, Belgium, Australia, and Brazil, and even smaller quantities go to several other countries.

Insofar as a country can be secure in a metal raw material supply without actually having all it needs within land transport distance of its borders, the U. S. is well off for bauxite and aluminum imports. The sea voyage from northern South America and the Caribbean Islands is as short and easily protected as any that could be imagined, and with continuing discoveries of new deposits of bauxite in those areas the picture is becoming more and more favorable.

THE 11 parts of *The International Mineral Trade Series*, which began in the May issue, will be available in reprint form in approximately 30 days at $1.00. Please address orders to Publications Dept., 29 W. 39th St., New York 18.

Table XVI. World Trade in Aluminum*, Tons
1952

		Importer								
Exporter	Total	U. K.	U. S.	Other Europe	Sweden	Belgium	Australia	Brazil	Misc.	Europe
Canada	412,589	256,368	122,000	24,000	—		5,523	4,257	—	(280,368)
Norway	35,054	10,000	—	—	15,119	4,738	—	—	5,200	(29,857)
Misc., Europe	15,000	—	15,000	—	—	—	—	—	—	—
Austria	12,500	—	—	—	—	—	—	—	12,500	—
France	9,662	—	—	—	—	5,939	—	—	3,700	(5,939)
Japan	5,000	—	5,000	—	—	—	—	—	—	—
Europe	(72,200)	(10,000)	—	—	(15,119)	(10,677)	—	—	—	(35,796)
	489,805	266,368	150,000	24,000	15,119	10,677	5,523	4,257	21,400	(316,164)
					1932 Asia	Japan	Russia			
Europe	22,100		2,400		2,900	3,000	10,600			—
Canada	11,500		1,300		700	2,500	—			6,000
U. S.	2,400		—		—	1,600	—			200
	36,000		3,700		3,900	6,300	10,600			6,800

U. S. Production 1952—937,330 short tons.
* Includes crude metal and alloys, plates, sheets, bars, etc., and scrap.

Heavy-Media separation plant and mine area, Keystone, S. D.

Mining and Concentrating Spodumene In the Black Hills, South Dakota

by Gerald A. Munson and Fremont F. Clarke

DURING recent years the use of lithium has expanded greatly in industrial, chemical, and metallurgical fields, while at the same time modernized methods of mining and refining lithium have increased production. Technical literature includes many papers describing the geology and mineralogy of lithium deposits. Mining and beneficiating problems, however, have not been thoroughly described. Published reports have failed to emphasize that one of the chief reasons lithium minerals were not extensively mined until recently is the difficulty of beneficiation.

Four lithium minerals of pegmatites and the lithium-sodium-phosphate byproduct from the brines at Searles Lake, Calif., have been sources of lithium. Among the pegmatite minerals, only spodumene and petaline are known to occur in deposits large enough to support large tonnage operations. Spodumene, a lithium-aluminum-silicate, is the principal lithium mineral mined in the U. S.

Lithium Corp. of America, during its rapid development and growth, has successfully employed three different methods of concentration: 1) hand sorting, 2) Heavy Media separation, and 3) froth flotation. Each method, though economic in its sphere, is becoming outdated as extractive techniques improve. The most recent development has taken place at Lithium Corp.'s new operation in North Carolina, where the extractive process yields lithium compounds directly from mined rock without an intervening concentrating step.

Until 1954 Lithium Corp. mined only in the southern part of the Black Hills of South Dakota, where the various types of lithium-bearing pegmatite could be used to develop untried processes of beneficiation. Concentrates from these operations are shipped to the corporation's chemical plant in St. Louis Park, Minn., where actual extraction of lithium and production of commercial compounds takes place.

G. A. MUNSON and F. F. CLARKE, Members AIME, are, respectively, General Manager of North Carolina Operations and Vice President and Production Manager, Lithium Corp. of America Inc., Minneapolis.

Discussion of this paper, TP 4081H, may be sent (2 copies) to AIME before Jan. 31, 1956. Manuscript, Feb. 9, 1955. Chicago Meeting, February 1955.

Nature of Deposits

The geology of the southern Black Hills pegmatite deposits is admirably presented by a U. S. Geological Survey publication.[1] Only the factors pertinent to exploitation need be mentioned here. Lithium Corp. has been interested primarily in three deposits, the Edison, the Mateen, and the Longview-Beecher No. 2. The history of these deposits dates back to the mining boom of 1880 to 1900 in the Black Hills, when most of the deposits were prospected for tin by the ill-fated Harney Peak Tin Mining Co. The three deposits described here, however, lay idle and unwanted until Lithium Corp. opened the Edison mine in 1943 and the Mateen and Longview-Beecher No. 2 in 1951.

Edison Deposit: The Edison deposit is about a mile southeast of Keystone, S. D., on the northeastern flank of the Harney Peak uplift. The deposit consists of no less than four and probably at least six separate pegmatites that coalesce in a central mass from which the individual pegmatites finger outward and downward in complexly folded schist and gneiss beds of the country rock.

The Transactions papers appearing in Mining Engineering during 1955 will subsequently appear in AIME Transactions Volume 202 and may be permanently referenced to that volume.

Each of the pegmatites has a wall zone consisting of quartz, albite feldspar, and muscovite, and a core consisting of spodumene, albite, and quartz. The internal structure is not readily recognized in the area where the pegmatites coalesce, but even here spodumene-bearing pegmatite can be readily distinguished from barren pegmatite for mining purposes. The central mass of this deposit measures 300 ft long by 150 ft wide and has been explored to a depth of 250 ft below the original outcrop.

Structure is further complicated by four major faults and a host of minor faults and fractures. Three of the major faults follow the trend of the long axis of the deposit and the fourth intersects the others at an angle.

The deposit averages 25 pct spodumene. Length of the spodumene crystals ranges from a fraction of an inch to 10 ft; the average is probably 1 ft. The mineral is free at 6 mesh or coarser size.

Mateen Deposit: The Mateen deposit on the southern edge of Hill City, S. D., is on the northwestern flank of Harney Peak and some 14 miles west of the Edison deposit. It consists of three and possibly four pegmatite dikes, which lie in close echelon, forming a ridge at the outcrop. Two of the dikes coalesce approximately 100 ft below the surface and outcrop as a single dike. The third has a narrow outcrop along the crest of the ridge and the fourth (or possibly the downward extension of the third) is seen only in development workings 200 ft below surface. All the dikes, plunging steeply to the north, are discordant to the foliation of the enclosing schists.

The main mass of the deposit is exposed along the surface for 700 ft in length and over 35 to 50 ft in width. It is known to extend an additional 250 ft in length on the 200-ft level.

The third dike outcrops over a length of 200 ft. The fourth shows a width of 30 ft in a crosscut on the 200 level, but its linear extent has not been determined.

The more southerly of the coalescing dikes stands nearly vertical, but its companion dips flatly eastward across the schist from the horizon of coalescence. The vertical dike appears to bottom shortly below the 200-ft level, but the other dike maintains its thickness at the greatest depth of exploration to date. The coalescing dikes form a single body in the surface workings, but a small parting has been observed some 35 ft above the 100-ft level. Fingers of pegmatite meander from the southerly end of the main mass. The dikes are laced with fracture partings, which admit percolating waters and contribute to minor weatherings and deposition of secondary minerals. This condition becomes pronounced in areas near the keel of the dikes.

All the dikes are zoned. The fine grained pegmatite 1 to 3 ft thick that encases the central mass is generally barren of spodumene and is composed of quartz, albite, microline, mica, and accessory cassiterite. The spodumene-rich core of this deposit contains about 20 pct spodumene; range in grade is from 15 to 35 pct. Spodumene crystals are uniformly oriented in a nearly horizontal position normal to the walls. The crystals are closely packed in a matrix of quartz-albite-microline pegmatite.

Contrary to earlier exploratory data, mining has shown that this deposit can yield a uniform product. Only near the keel of the vertical dike is the lithium content low, and no barren areas of any size have been encountered. Otherwise the spodumene content at the 200-ft level is the same as in the surface pits.

Fig. 1—Mateen open pit and underground development structures, Hill City, S. D.

The spodumene crystals range downward from about 10-in. length, averaging perhaps 6 in. The mineral is free when crushed to 50 mesh.

Longview-Beecher Deposit: The Longview-Beecher No. 2 deposit is located far out on the southwestern flank of Harney Peak range, some four miles south of Custer, S. D., and 18 miles south of the Mateen deposit. This deposit is one of a series of three major pegmatites, including the widely publicized Beecher lode and the Beecher No. 3 beryl mine. All strike northward and dip steeply to the west concordantly with the enclosing schists. The Longview-Beecher dike is separated from the other two dikes by more than 50 ft of country rock.

Roof pendants and rolls of country rock indicate that only the uppermost reaches of the dike have surfaced. The deposit outcrops solidly over a length of 1200 ft and has a fairly constant width of 200 ft. Spodumene-rich pegmatite is exposed in major areas aggregating some 78,000 sq ft. Three areas have been exploited to some extent. The main mass to the south covers an area 170x100 ft while another mass in a southwesterly extension of the pegmatite is exposed over a length of 180 ft and average width of 80 ft. These units have been explored only 150 ft below the outcrop. For the most part the spodumene is contained in a quartz-albite matrix, but microcline is common. The spodumene crystals show no orientation. They range in size from a fraction of an inch long to rare crystals 6 ft long, averaging less than 1 ft. The spodumene is free at 50 mesh.

Other Deposits: The Black Hills have many other lithium pegmatites including the famous Etta mine, which contains spodumene crystals up to 47 ft long.

Many crystals in the deposit are 10 ft long. In contrast, the Tinton deposit, in the northern Black Hills, contains few spodumene crystals visible to the naked eye, and the largest are no more than ¼ in. long. At Tinton the spodumene is free at 100 mesh or finer.

The theoretical maximum lithia content of spodumene, $LiAl(SiO_3)_2$, is 8.0 pct, but the highest grade specimens contain no more than 7.5 pct Li_2O. The difference is accounted for partly by substitution of other elements for Li in the spodumene lattice; partly by the presence of quartz, feldspar, and mica that enter even the cleanest concentrates; and partly by alteration of spodumene to micaceous and clayey minerals.

Weathering is most pronounced along and near fault planes and to a lesser degree along the more remote fracture patterns. It is most often accompanied by deposition of ferrous or manganous clay fractions or stains upon the mineral affected. Sometimes the color cast may extend throughout the attacked minerals; otherwise it is confined to the surface, fracture, or cleavage planes.

Spodumene crystals tend toward euhedral form, but most crystals are in part embayed by adjacent minerals. The thickness-width-length ratio approximates 1:2:12, but the long axis may be far greater than the others. In many deposits the crystals show no orientation and in rich deposits are intergrown in jackstraw patterns. In some deposits, however, spodumene crystals are oriented perpendicular to the contact.

The color is usually white or gray but may be light to dark brown, blackish, reddish, greenish, or bluish depending on impurities or alteration. Pink spodumene (kunzite) and green spodumene (hiddenite) are rarely found. A common alteration product is a dull, soapy, green material very low in lithia.

The spodumene readily breaks free of the matrix on crushing and grinding, the fine crystal fragments tending to break into long needlelike splinters or flat rectangular particles. Under 100X magnification many of these particles show parallel, longitudinal traces of altered material. In hand specimens, a claylike coating may be scraped from cleavage surfaces in all but the freshest and hardest specimens.

Mining

Spodumene pegmatite had never been mined by modern mechanized techniques prior to the time Lithium Corp. began operations in the area. Many deposits worked for feldspar, mica, beryl, and lithium minerals were too small for mechanized mining, but the Edison deposit presented a good opportunity for developing mass mining operations. During the formative years of Lithium Corp. spodumene was concentrated by hand sorting, and initial exploitation of the Edison was geared to this productive rate. An open cut was started near the bottom of a draw bordering the base of the pegmatite exposure, about 115 ft below the highest outcrop. This pit cut into the most westerly dike and for a time supported the operation. Then an adit was started from the pit eastward 125 ft to transect the other dikes, a room was cut along the footwall over a length of 100 ft, and stope raises were driven and expanded to form a glory hole some 110x80 ft at surface.

By 1947, when increased demand for lithium required more rapid and efficient exploitation, the corporation transferred a ¾-yd P&H shovel to the

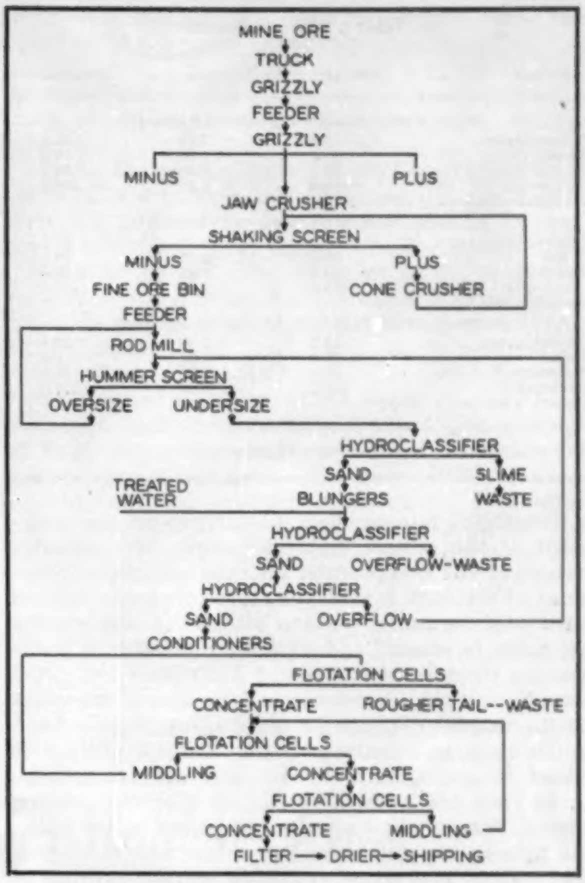


Fig. 2—Flowsheet of operations at Hill City, S. D.

property and began the first mechanized lithium operation in the southern Black Hills. All of the deposit above the adit level was then mined as one open pit.

Subsequent operations lowered the floor of the pit 60 ft below the adit level. Reserves below this level are in divided remnants of the pegmatite, and mining returned to underground methods.

Equipment was moved to the Mateen mine at Hill City, where the pegmatite outcrop forms a 170-ft high ridge. A series of horizontal benches were driven along the strike of the deposit, and access is easily maintained by slabbing short entry cuts in the exposed sheath of country rock. The Beecher mine is also an open pit, but there the topographic relief is very low, a disadvantage offset by the great area of spodumene-bearing pegmatite. As mining progressed from operation at the Edison to later operations at the Mateen, Fig. 1, and Beecher, techniques for breaking and moving ore and waste improved. After the ¾-yd shovel was put in operation, 1½-ton trucks displaced the hand mining system of the Edison open pit and have continued in use at later operations at the Mateen and Longview-Beecher mines. Experience soon taught that best results were obtained by carrying a 12-ft face drilled horizontally on a basic 3x4-ft pattern to a depth of 16 ft. Blasting is successful with an average 1 lb of 45 pct Gelex dynamite per ton of rock, and no more than 5 pct of the broken material requires secondary blasting. Originally the oversize was laid aside in the pit, blockholed, and blasted, but more recently plastering with 60 pct gelatin dynamite for secondary breakage has given good results.

Table I. Mill Run Results

Product	Weight, Pct	Lithia, Pct	Distribution
No. 1. Partly Altered Spodumene Pegmatite			
Concentrate	15.9	4.92	63.5
Slime	31.8	0.68	17.2
Tail sand	52.3	0.46	19.3
Composite	100.0	1.26	100.0
Flotation efficiency,* 75.8 pct			
No. 2. Altered Spodumene Pegmatite			
Concentrate	13.1	5.13	57.1
Slime	38.3	0.75	24.1
Tail sand	48.6	0.46	18.8
Composite	100.0	1.21	100.0
Flotation efficiency, 76.0 pct			
No. 3. Hard Rock with Altered Spodumene			
Concentrate	14.2	3.94	66.4
Slime	20.4	0.53	12.6
Tail sand	65.5	0.27	21.0
Composite	100.0	0.82	100.0
Flotation efficiency, 76.0 pct			

* Lithia recovery from deslimed flotation feed.

Successful mining depends largely on the judgment of the miners and pit bosses. The variable nature of the composition and the structural character of the rock is such that it is unwise to depend on a predetermined pattern of drilling and loading the holes. In mining, indiscriminate blasting of waste and ore together is avoided by alert attention to the variation in rock hardness and by noting the composition of the cuttings during drilling. Where hard, tough rock is encountered the drilling pattern is closed accordingly, and with soft or highly fractured rock the pattern is extended or the loading spaced. Where waste rock is recognized in the holes, the hole is stopped near the contact and blasted to that point. The waste is probed during drilling of the next round and the waste is blasted and disposed of separately. Remnants are carefully probed and slabbed to maintain clean faces and adequate working space for the equipment. Usually three working faces are maintained for each mine crew.

The power shovel operator becomes adept at rough sorting of ore and waste from the blasted material. Tractor front-end loaders have also been used recently.

Concentration of Spodumene Ore

Hand Sorting: During the earliest operation at the Edison mine spodumene was hand sorted at the mine face, but subsequently a picking belt was installed. The arrangement consisted of a 12-in. rail grizzly, ore bin, 18x30-in. jaw crusher, shaking screen with 1½-in. square mesh cloth, transfer conveyor, surge bin, and 30-in. flat picking belt 30 ft long. The −1½-in. material was removed by a small lateral conveyor.

The picking belt was housed over the final ore bin, which was divided to receive both reject material and spodumene concentrate. The concentrate was hauled to the railroad at Keystone for shipment and the reject to waste dumps near the mine.

Production data shows that the sorting operation yielded 10.5 pct by weight of mine run rock as a concentrate which averaged 4.8 pct lithia. Quartz, feldspar, muscovite, and alteration products of spodumene contaminated the concentrate.

The −1½-in. material, representing 43.5 pct by weight of the crude feed, was stockpiled for future concentration. The crude feed contained 1.1 pct lithia, and the undersize rejects contained 1.76 pct lithia.[8] About 0.4 ton of barren pegmatite and country rock per ton of crude feed was rejected at the mine face before delivery to the sorting circuit.

Heavy Media Separation: Early in 1949 a Heavy Media separation plant was put into operation to increase production at the Edison mine. This was the first plant ever to employ this process to separate minerals having such similar properties as the pegmatite minerals.

The plant consisted of a 12-in. grizzly, crude ore bin, 18x30-in. jaw crusher, shaking screen (1½ in. square mesh), 9x16-in. jaw crusher set at 1½ in. for the oversize, conveyor, truck haulage to 250-ton mill bin, 20-in. belt feeder, a 3x8-ft split deck Niagra screen, 35-in. bucket elevator, and a Wemco Mobilmill with 5-ft separatory cone.

Mill feed was −1½-in. crushed pegmatite. Undersize was wet screened at 6 mesh on the Niagra screen, and the coarse material elevated and fed to the cone. Minus 200 mesh ferrosilicon and water was the medium for the separatory cone. Occasionally, as much as 10 pct magnetite was added to the slurry to balance magnetic characteristics of the solid media.

The difference in specific gravities of the pegmatite minerals is very small for this type of separation. Typical figures are listed as follows:

Spodumene	3.1
Quartz	2.65
Microline	2.56
Albite	2.60
Muscovite	2.76 to 3.1
Apatite	3.2
Tourmaline	3.0 to 3.2
Triphylite	3.4 to 3.56

Because altered spodumene containing micaceous and clay minerals has a lower specific gravity than pure spodumene, the difference in specific gravity between spodumene and gangue may be virtually nil.

Perhaps the most important difficulty in gravity separation of spodumene is its characteristic breakage to acicular particles which even in a minor current become buoyant and tend to float off with the gangue minerals. This characteristic prevented the success of attempts to treat the −6 mesh fraction in a Dutch State Cyclone circuit, although laboratory test work showed efficient separation to 35 mesh.

The plant successfully treated Edison ore at 12 tph of crude feed, yielding the following results:

Product	Weight, Pct	Lithia, Pct	Distribution, Pct
Sink	7.1	5.36	47.4
Float	66.5	0.16	13.4
Fines	26.4	1.19	39.2
Composite	100.0	0.80	100.0

These results, obtained at 2.70 sp gr, were the best obtainable from low grade feed.

Flotation Concentration: Early in 1951 a research project was undertaken to determine the best methods of concentrating the fine grained pegmatite of the Beecher and Mateen lodes. It was soon learned that the spodumene could be beneficiated satisfactorily by the relatively simple procedure of desliming, caustic blunging, and collecting and floating with an anionic fatty acid. In general the process follows Falconer[9] and other writers of the 1940's. Clean mica and feldspar concentrates were also obtainable. Unfortunately, however, neither feldspar nor mica could be readily marketed. The soda and potash content of the feldspar concentrate could not be controlled well enough to meet marketing conditions while the flake size of the mica concentrate

grain size was too large for use as wet ground mica and too small for use as dry ground mica. The silica sand tailings could not be transported profitably to market under prevailing freight rates. The mill as finally operated, therefore, is used solely to concentrate spodumene.

The plant constructed at Hill City, S. D., was put into operation early in 1952. It has operated successfully without major change except that the classifier in the grinding circuit has been replaced by Hummer screens. The plant is comprised of standard metallurgical equipment, but some of the equipment has had to be modified to correct for the rapid pulp settling rate and the extreme abrasiveness of the pegmatite material. The generalized flowsheet is shown in Fig. 2.

Location of the plant in the heart of a National Forest and in a widely publicized recreational area makes it necessary that waste water returning to the drainage area be entirely free of contamination. Mill waste is pumped some 200 ft vertically and 2000 ft horizontally to dry draws where the solids are settled in normal tailing ponds equipped with underdrains to bleed the clarified water from the back of the lagoons. The dams are constructed of the tailing sands after dewatering in sand cones that are located at the discharge end of the tailing pump lines and at the heads of the distributing launders. The overflow liquid from the cones is directed to the pool of the lagoon. Crude burnt lime fed at the overflow of the cones effectively coagulates the dispersed slimes. The double diking method[4] of dam construction provides adequate pool area in the relatively narrow and steep draws to permit winter operation.

Insofar as possible, therefore, mill control has been made fully automatic so that operators may devote their full attention to pulp trends. Milling of pegmatite is subject to even more intuitive control than the mining operations, for added to the continual variations in the mineral character and associations, attention must be given to the dissolved mineral content of the pulp, pulp temperature, and pH as well as to changing mechanical and hydraulic conditions related to nature of the feed.

Metallurgical control is based chiefly on analysis by flame photometer, but grain estimates under the microscope are also used. Microscope determination applied to critical products in the circuit gives adequate information for proper adjustment of the machines. Typical mill results on three ores are given in Table I.

References

[1] L. R. Page et al.: Pegmatite Investigations 1942-1945. Black Hills, S. D., Geological Survey Prof. Paper 247, 1953.

[2] Fremont F. Clarke et al.: Edison Spodumene Mine, Pennington County, South Dakota. U. S. Bur. Mines R. I. 4234, 1948.

[3] S. A. Falconer and B. D. Crawford: Froth Flotation of Some Non-sulphide Minerals of Strategic Importance. *AIME Trans.*, 1946, vol. 169.

[4] V. A. Zanadvorf: Disposal of Mill Tailings at Holden Concentrator. *AIME Trans.*, 1946, vol. 169.

Extraction of Lithium from Its Ores

Lithium chemical plant extraction methods are discussed with reference to 1) base exchange with alkali sulphates; 2) processing based on roasting with lime; 3) miscellaneous methods; and 4) application of the Lithium Corp. process to extraction of lithium from run-of-mine, low grade spodumene ore, or concentrates.

by Reuben B. Ellestad and Fremont F. Clarke

IN the early days of the lithium industry most of the production was from lepidolite, zinnwaldite, and amblygonite. Nearly all the early extraction processes described in the literature involve heating the finely ground mineral with sulphuric or hydrochloric acid. On subsequent water leaching most of the bases present in the mineral (especially aluminum) are dissolved as sulphates. As a result, the leach solution required extensive chemical purification before the lithium could be precipitated as carbonate. Following the remarkable growth of the lithium industry to its present size, zinnwaldite and amblygonite ores must be considered of minor importance only. Attention is now focused on spodumene, abundant enough in North America to be a major source of supply, and there are important supplies of lepidolite and petalite in Africa. The extraction processes described below all apply to spodumene, although several will also operate on other lithium minerals, such as petalite.

Base Exchange with Alkali Sulphates: A distinct advance was made with the disclosures of Wadman and von Girsewalt. In these methods the finely ground silicate ore (spodumene or lepidolite) is intimately mixed with an excess of alkali sulphate (usually K_2SO_4) in at least a 1 to 1 proportion, and the mixture was heated to a relatively high temperature. Base exchange results, with the formation of lithium sulphate. A water leach dissolves the lithium sulphate, together with the excess potassium sulphate. Successful operation of this type of process requires very thorough grinding and mixing, as well as careful temperature control. The use of K_2SO_4 is objectionable from cost considerations since purification of lithium carbonate requires the use of potassium carbonate, if the K_2SO_4 is to be recovered and recycled. The lower solubility of K_2SO_4 as compared with Na_2SO_4 is also objectionable, since it limits the concentration of the Li_2SO_4 solution to be precipitated by K_2CO_3. Early laboratory-scale investigation of this process by Lithium Corp. was not encouraging.

Other related base exchange processes are those of Lindblad, Wallden, and Sivander[3] and Sivander, Gard, Villestad, and Wallen[4]. The former covers the reaction of lithium silicate minerals with a sodium sulphate solution, at 100° to 300°C (under pressure), while the latter involves the extraction of silicate minerals with molten sodium sulphate. Both these processes would seem to be difficult and expensive to operate.

R. B. ELLESTAD is Director of Research and F. F. CLARKE, Member AIME, is Vice President and Production Manager, Lithium Corp. of America Inc., Minneapolis.

Discussion of this paper, TP 4079BH, may be sent (2 copies) to AIME before Jan. 31, 1956. Manuscript, Feb. 9, 1955. Chicago Meeting, February 1955.

Processes Based on Roasting with Lime: Several processes have been described in which the finely ground ore is mixed with either CaO or $CaCO_3$ and heated. On water leaching, LiOH is dissolved and separated from the insoluble residue.

The first of these is the patent of Rosett and Bichowsky,[5] which covers mixing the ore with $CaCO_3$ in a 1:2 ratio and heating to 800° to 1000°C until it is clinkered. Grinding and leaching follow. The process of Colton[6] is very similar. Next is the patent of Nicholson[7] in which beta-spodumene* is autoclaved with $Ca(OH)_2$ and water. An alternate procedure is also covered, in which alpha-spodumene is mixed with $CaCO_3$, in a 1:2, or 1:2.7 ratio, and heated to a temperature of 1000° to 1230°C, followed by leaching. The process of Stauffer[8] involves heating a mixture of spodumene and CaO, in a 1:3 ratio, in a vacuum of 0.01 mm at 1150°C, with the distillation and condensation of lithium oxide, Li_2O, which dissolves in water to form LiOH. Finally there is the process of Kroll[9] in which ground spodumene is mixed with $CaCO_3$ in a 1:0.2 ratio and fired at high temperature, followed by leaching in an autoclave under pressure with various salt solutions, such as Na_2SO_4.

* This is natural, or alpha-spodumene, which has been heated to approximately 1100°C.

Strictly speaking, the reactions involved in these lime processes are probably not simple base exchange reactions, in which calcium replaces lithium. Except in the process of Stauffer, it is doubtful if free Li_2O is present after the sintering operation. It seems more likely that a lithium calcium silicate or aluminosilicate is formed, which on hydrolysis yields LiOH. In principle these methods are all attractive, in that the lithium compound first obtained on leaching is LiOH, which can be converted to other salts without the necessity of going through the carbonate stage.

Miscellaneous Processes: Several processes have been proposed in which spodumene and sometimes amblygonite is mixed with $CaCO_3$ and either $CaSO_4$ or $CaCl_2$, followed by heating. Sternberg, Hayes, and Williams[10] mix spodumene, $CaCO_3$, and $CaSO_4$ in the weight ratios 1:1:0.6, heat to 1100°C for 2 to 3 hr, and leach out lithium sulphate. Similarly Kalenowski and Runke[11] mix spodumene, or mixtures of spodumene and amblygonite, with $Ca(OH)_2$ and gypsum ($CaSO_4 \cdot 2H_2O$) in the weight ratios of 1:2:1, heat to 1050°C for 2 hr, and leach out lithium sulphate. The process of Sternberg, Hayes, and Williams was tried out on a plant scale by Lithium Corp. and found to be very difficult to operate. In the kiln heating operation, the lithium sulphate and the excess $CaSO_4$ present formed low melting mixtures which caused serious problems.

Fraas and Ralston[12] describe a method in which spodumene is mixed with $CaCO_3$ and $CaCl_2$, followed by heating in a kiln to a temperature sufficiently high to volatilize LiCl, which is condensed and collected. This process has been tried on a large scale, but was not successful.

Another process is that of Kepfer and Pfanstiel[13] in which spodumene and $CaCl_2$ are mixed in a ratio of 3:1 to 1:1 and heated at 760° to 925°C for 2 hr, followed by leaching out lithium chloride.

Finally there is the process of Erasmus[14] in which spodumene ore (1.2 pct Li) is mixed with $CaCl_2$ in the weight ratio of 4:1 and heated under reduced pressure (2.5 to 5 mm) at 1050° to 1150°C for 3 to 5 hr. The volatilized reaction products are condensed and LiCl recovered (96.5 pct recovery) by alcohol extraction.

Lithium Corp. Process: The process used at present by Lithium Corp. for the extraction of lithium from spodumene is that of Ellestad and Leute.[15] The first step in this method is the conversion of natural alpha-spodumene to beta-spodumene by heating in a kiln to about 1100°C. After grinding, the beta-spodumene is mixed with an excess of 66° Be sulphuric acid and heated in a smaller kiln to about 250°C, with a retention time of about 10 min at temperature. This results in a true exchange reaction, in which lithium ions in the beta-spodumene structure are replaced by hydrogen ions, with the formation of lithium sulphate, which is leached and separated from the ore residue. Details of these operations are given by Hader, Nielsen, and Herre.[16]

Some of the advantages of this process are:

1) It is not necessary to mix the ore with solid reagents. Adequate mixing with sulphuric acid is a much easier operation.

2) Extreme fine grinding of the ore is not necessary. This follows from the fact that due to the porous nature of beta-spodumene, a relatively large particle will effectively absorb sulphuric acid. This is in contrast to most of the other processes, which are based on solid phase reactions requiring very fine grinding of both ore and reagent, as well as intimate mixing, if maximum recovery is to result.

3) Both the kiln operations used in this process require heating at temperature for only a relatively short time. In the first kiln operation, in which alpha-spodumene is converted to beta-spodumene, the inversion is practically instantaneous at 1100°C, and only a matter of minutes at 1075°C. Also, in the actual extraction operation, only a relatively low temperature of 250°C is needed, with retention time of only about 10 min at temperature. This is in contrast to most of the processes described. One advantage of this low reaction temperature is that fusion of lithium sulphate does not take place, thus eliminating one of the troubles of the process using a lime-gypsum roast.

4) After the heating with sulphuric acid at 250°C, no grinding is needed prior to leaching with water, unlike most of the other processes.

5) Water leaching of the acid roast ore is rapid and is not affected by leaching with moderately strong lithium sulphate solutions.

6) It is the authors' opinion that proper utilization of this process results in an efficiency of lithium recovery not achieved by any of the other methods.

7) It is also their opinion that this process is the only one that lends itself to efficient direct extraction of lithium from low grade, run-of-mine ore.

Chemical Plants at Minneapolis and at Bessemer City, N. C.: The Lithium Corp. of America Inc. chemical plant at Minneapolis was designed for the use of spodumene concentrates. These are chiefly flotation concentrates, although coarse ore concentrated by either hand-picking or sink-float methods has been used. During the past year a considerable tonnage of petalite was also processed.

The method of extraction used at Minneapolis is the sulphuric acid roast of beta-spodumene, following the patent of Ellestad and Leute referred to previously.[15]

In brief, the first step is the conversion of natural alpha-spodumene to beta-spodumene in a kiln operation. Coarse ore is crushed to 1 to 2 in. size before being fed into the kiln, whereas flotation

concentrates are used directly. The kiln, 40 ft long and 4 ft ID, is lined with fire brick and gas-fired countercurrent to the flow of ore, rotating at about 1 rpm. The hot zone is at a temperature of 1050° to 1100°C. Capacity is 2 tph of concentrate feed. After cooling in a rotary cooler the ore is ground in a Williams mill. The ground ore is then mixed with 66° Be sulphuric acid, using approximately 40 pct excess above the theoretical requirement. The ore is then fed into a small unlined rotary kiln, 26x3 ft, which is gas-fired concurrent to the ore flow. Discharge temperature is 250°C. The lithium sulphate from this operation is water-leached from the ore residue in air-agitated Pachuca tanks of 8000-gal capacity. Ground limestone is added to the ore slurry in the leach tanks to neutralize the excess sulphuric acid and to precipitate the small amount of soluble iron and aluminum salts present. The slurry is filtered and washed in a vacuum drum filter. The solids are discarded, and the filtrate, containing about 100 g per liter of lithium sulphate, is treated for removal of calcium, magnesium, iron, and aluminum. The solution is concentrated by evaporation to about 200 g per liter of lithium sulphate. The primary product of lithium carbonate is produced by reaction of this solution with soda-ash. Owing to the appreciable solubility of lithium carbonate in the mother liquor, it is necessary to remove sodium sulphate from the lithium carbonate filtrate and return the solution to the tank room system.

The lithium recovery of the above process, when operating on spodumene concentrates of 4 to 5 pct Li_2O, is about 85 pct. If this figure is coupled with a realistic figure of 60 pct for the recovery of lithium in flotation concentration, the result is an overall efficiency of only 45 to 50 pct. In view of this, when Lithium Corp. investigated the utilization of its North Carolina ore holdings, attention was given to the possibility of using its sulphuric acid process directly on run of mine ore. Continuous large-scale tests have shown that an overall recovery of 80 pct is very feasible, in contrast with the 45 to 50 pct overall recovery when preconcentration methods coupled with chemical plant processing are utilized. As a result, the chemical plant at Bessemer City, N. C., treats run of mine ore direct without preconcentration. Except for capacity, and the use of more appropriate equipment for performing the unit steps in the process, especially with regard to the larger amount of material involved, the process at Bessemer City is essentially the same as that used at Minneapolis.

References

[1] U. S. Patent 847,856; 1906.
[2] U. S. Patent 1,710,556; 1929.
[3] U. S. Patent 2,331,838; 1943.
[4] U. S. Patent 2,230,167; 1941.
[5] U. S. Patent 2,020,854; 1935.
[6] U. S. Patent 2,021,987; 1935.
[7] U. S. Patent 2,413,644; 1946.
[8] U. S. Patent 2,424,512; 1947.
[9] U. S. Patent 2,622,809; 1953.
[10] *U. S. Bureau of Mines R.I.* 3848, 1946. U. S. Patent 2,533,246.
[11] *U. S. Bureau of Mines R.I.* 4863, 1952.
[12] *U. S. Bureau of Mines R.I.* 3344, 1937.
[13] U. S. Patent 2,022,003; 1935.
[14] U. S. Patent 2,561,439; 1951.
[15] U. S. Patent 2,516,109; 1950.
[16] *Industrial and Engineering Chemistry*, 1951, vol. 43, p. 2036.

Errors in Underground Air Measurements

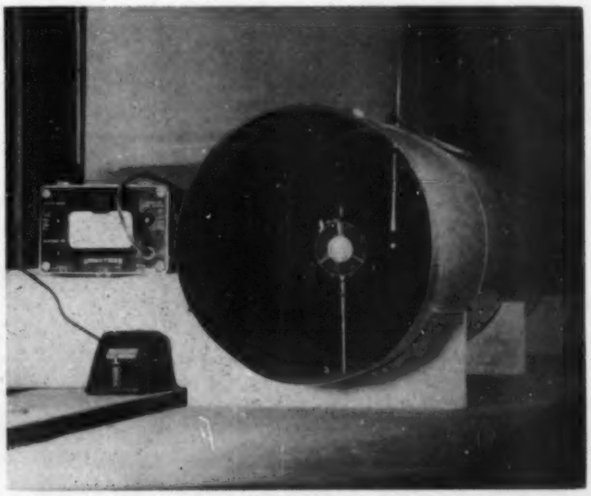
Stefan Boshkov and Malcolm T. Wane

THE validity and accuracy of velocity measurements underground have been questioned repeatedly by those in mine ventilation work. The general disagreement on the subject is well illustrated in an AIME publication.[1] Although the presence of errors is readily admitted, their magnitudes are not known and often are described by practical operators merely as "great," "small," or "of no importance." The belief that errors are of academic interest only prevails because of a justifiable claim that actual volumes of air circulated are well in excess of those required by law and safe mining practices.

Poor understanding of the source and nature of errors inherent in velocity measurements, coupled with questionable determination of cross-sectional area, result in faulty techniques for the purpose of expediting ventilation surveys and render doubtful the calculated volume. Often consistency of readings is confused with accuracy. A succession of check readings showing a maximum deviation of 5 pct in the measured value of velocity usually signifies nothing more than diligent application of technique in a stable ventilating current.

S. BOSHKOV, Member AIME, is Assistant Professor of Mining Engineering and M. T. WANE is Associate in Mining, School of Mines, Columbia University, N. Y. C.

Discussion of this paper, TP 4124A, may be sent (2 copies) to AIME before Jan. 31, 1956.



Experimental wind tunnel for laboratory testing is shown above.

This article discusses the errors involved in air measurements underground. Where instrument errors are presented, the treatment is confined solely to the rotating-vane anemometer, recognized as a most useful ventilation measurement tool because of its simple design and easy operation. In the following pages a positive deviation is defined as one which has to be added to the registered air velocity to obtain the true air velocity.

Sources of Error

Errors affecting the accuracy of velocity readings may be classified as follows:

A. Errors inherent in the instrument, a function of its physical construction.

B. Errors resulting from differing atmospheric conditions.

C. Errors resulting from operator technique, which include:

1. Instrument position and support:
   - a. Instrument orientation.
   - b. Operator proximity.
   - c. Operator position.
2. Surveying procedure:
   - a. Location and preparation of section.
   - b. Single readings.
   - c. Multiple readings: continuous and intermittent traversing.

Instrument Errors

Translation of true air velocity into registered velocity in a rotating-vane anemometer is accomplished through vanes, bearings, and gear assembly. This registered velocity is dependent on the mechanical efficiency of the system, which in turn is a function of the frictional resistance of the bearings. The bearing friction may be expressed in the following form:[2]

$$F = \mu W + \mu D \qquad [1]$$

where F is the frictional resistance, W the weight of the moving parts of the anenometer, D the end thrust on the bearings resulting from the action of the wind force on the vanes, and μ the coefficient of bearing friction.

If μ is assumed to remain constant, the above equation reduces to

$$F = a + bD \qquad [2]$$

where a and b are constants that depend on the physical construction of the instrument. The manufacturer's calibration curve, Fig. 1, evaluates experimentally the error resulting from changes of this frictional resistance with wind force, which in turn depends on true air velocity. Since bearing friction is contingent on the physical condition of the bearing, this error may be expected to vary with use and degree of instrument exposure to detrimental dust and water. To correct for this change in the coefficient μ, the manufacturer recommends periodic recalibration against a standard.

Effect of Atmospheric Conditions

The calibration curve, Fig. 1, is obtained under some set of standard atmospheric conditions. The error incurred in neglecting changing atmospheric conditions has been analyzed.[3] A revised theoretical development as well as practical implications ensuing from it follow.

The windmill-type anemometer consists of a series of flat plates whose aerodynamic force characteristics can be represented by a Joukowsky profile and evaluated by the formulas[3]

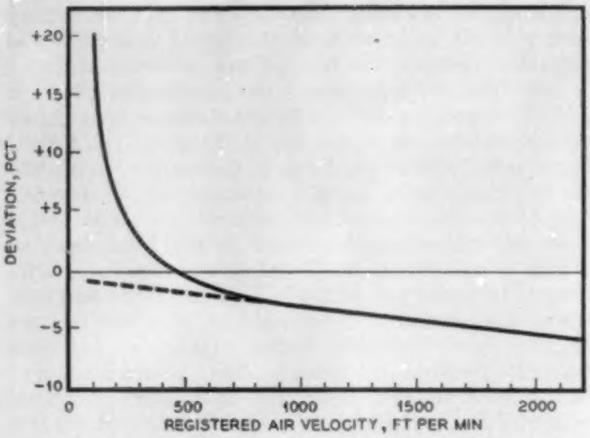


Fig. 1—Typical manufacturer's calibration curve for rotating-vane anemometer.

$$L = C_L mlc \frac{\rho V_{T0}^2}{2} \qquad [3]$$

$$D = C_D mlc \frac{\rho V_{T0}^2}{2} \qquad [4]$$

where L and D are the net forces of lift and drag, acting on the vane surfaces perpendicular and parallel to the wind direction, C_L and C_D are coefficients of lift and drag, m represents the number of vanes, l and c the vane dimensions, ρ the air density, and V_{T0} the true air velocity.

The resulting torque in the instrument, T_0, in a steady state of air flow is then given by

$$T_0 = C_L mlc \frac{\rho V_{T0}^2}{2} r, \qquad [5]$$

where r is the moment arm of the net lift force.

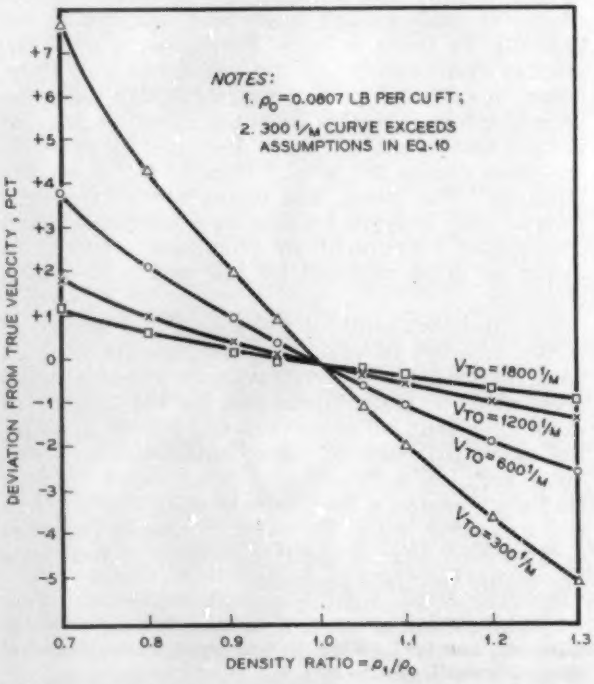


Fig. 2—Typical error resulting from density variations and its dependence on true velocity.

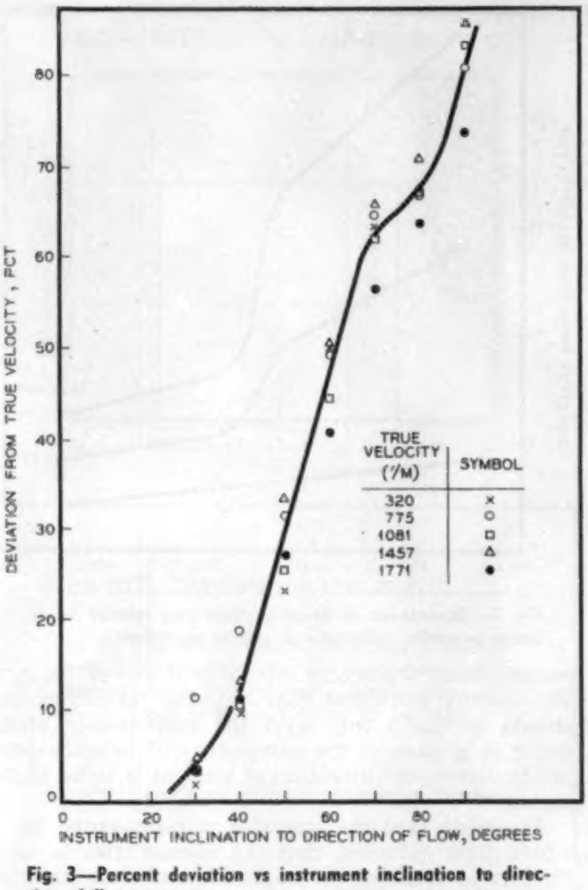


Fig. 3—Percent deviation vs instrument inclination to direction of flow.

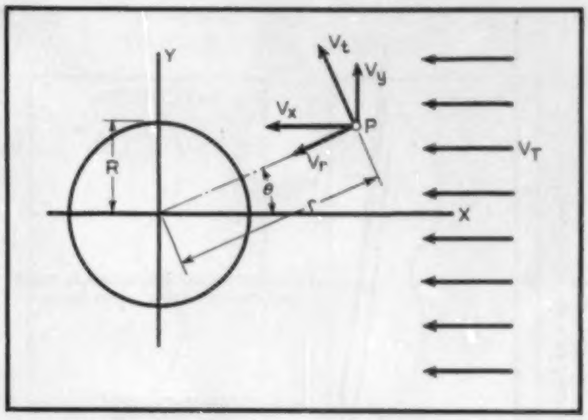


Fig. 4—Velocity components in the vicinity of a cylinder.

If the density of the air changes from ρ_0 to ρ_1, there will be a certain value of true air velocity V_{T1} such that the resulting torque T_1 will equal the torque T_0. Therefore, it may be written

$$C_L mlcr \frac{\rho_0 V_{T0}^2}{2} = C_L mlcr \frac{\rho_1 V_{T1}^2}{2} \qquad [6]$$

which may be reduced to

$$\rho_0 V_{T0}^2 = \rho_1 V_{T1}^2. \qquad [7]$$

It has been shown that for the same instrument the functional relationship between the registered velocity and true velocity is such that the following ratio exists:

$$\frac{V_{R0}}{V_{R1}} = \frac{V_{T0}}{V_{T1}} = \sqrt{\frac{\rho_1}{\rho_0}}. \qquad [8]$$

A reference to Fig. 1 clearly shows that if low air velocities are neglected, the calibration curve may be expressed as a linear equation, viz.,

$$V_{T0} = A\,V_{R0} + B \qquad [9]$$

where A and B are constants depending on air density at calibration.

Different calibration curves exist for other air densities, giving rise to a family of curves. By use of Eqs. 8 and 9 it may be shown that each curve in the family has the same slope, i.e.,

$$A = A_1 = A_2 = \ldots$$

and that the intercepts, B, are given by

$$B_1 = \sqrt{\frac{\rho_0}{\rho_1}}\,B. \qquad [10]$$

Fig. 2 shows graphically the error resulting from density variations and its dependence on the true air velocity.

Operator Technique and Survey Accuracy

The errors resulting from operator technique are probably the least understood and most difficult to evaluate. Although these errors lend themselves to theoretical analysis, most of them defy quantitative evaluation and must be determined experimentally.

Instrument Orientation: Errors resulting from instrument orientation were ascertained by laboratory testing in a wind tunnel. A new MSA 3-in. diam rotating-vane anemometer was tested. The true air velocity was varied by an orifice at the fan outlet. A continuous reading hot wire anemometer was used as an indicator of stability of air flow. Individual readings were taken at different instrument orientations over a 2-min interval. The results summarized in Fig. 3 represent the mean of at least two readings, with a maximum deviation of 0.3 pct. The test work indicates: 1) that inclination up to about 20° does not affect the registered velocity, and 2) that this error appears to be independent of the magnitude of the true air velocity.

It may be concluded that this error may be disregarded if velocity measurements are determined with diligence. Fig. 3 shows the effect of rotating the instrument clockwise. Counterclockwise rotation altered the readings slightly, with the exception of the 80° and 90° readings, where physical construction of the instrument caused reversal of vane rotation. Deviations in this case did not occur until the inclination was greater than 15°.

Operator Proximity: Errors in velocity measurements resulting from operator proximity can be analyzed theoretically and have been determined within certain velocity ranges under controlled test conditions underground.[4] A theoretical analysis using the laws of fluid flow is limited to expressing solutions for velocity and pressure distribution around mathematically describable bodies. The theoretical approach is based on the assumption of irrotational flow in which friction plays a minor role and high values of Reynold's number prevail. The human

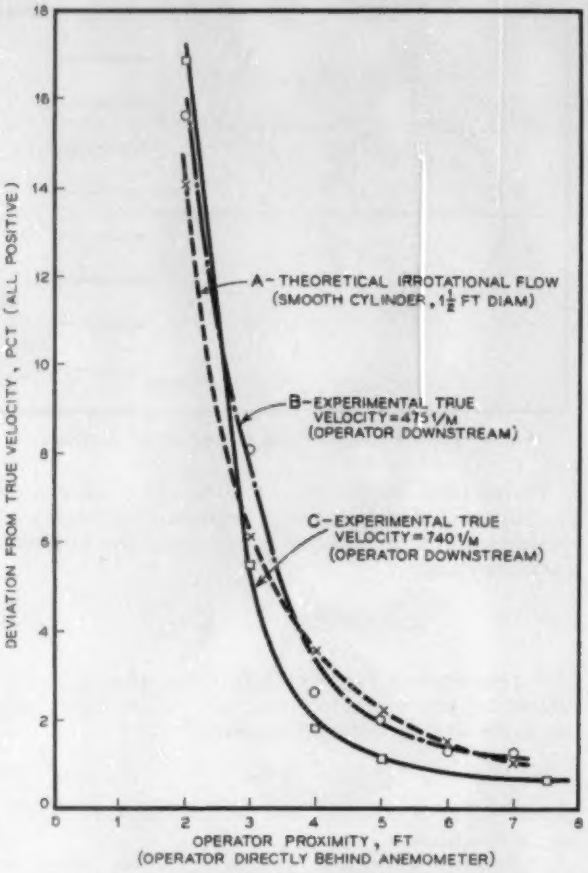


Fig. 5—Deviation from true velocity vs operator proximity.

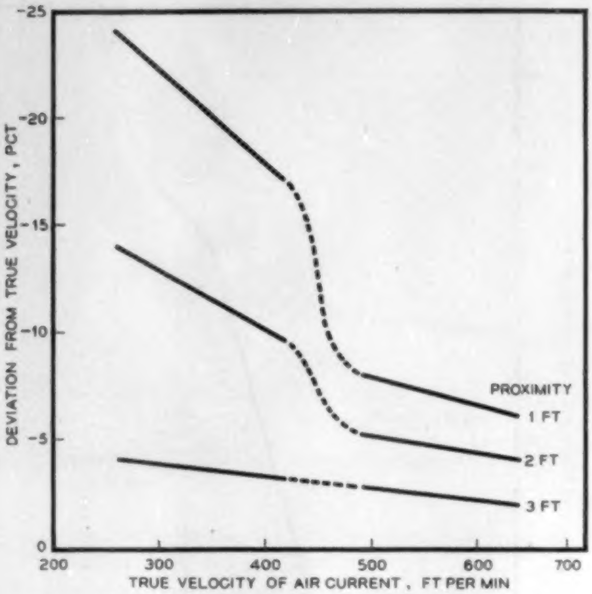


Fig. 7—Dependence of deviation from true velocity on operator proximity. (Operator at side of instrument).

body may be approximated by the ideal form of the cylinder, for which the two dimensional solution is given below:

$$V_r = V_T \cos\theta\left(1 + \frac{R^2}{r^2}\right) \qquad [11]$$

$$V_t = V_T \sin\theta\left(1 + \frac{R^2}{r^2}\right) \qquad [12]$$

where, as shown in Fig. 4, V_T is the true air velocity, V_r and V_t are the radial and tangential components at P, and θ, R, and r are defined in the sketch.

Eqs. 11 and 12 may be solved for V_x and V_y, the velocity components parallel and perpendicular to the drift axis.

$$V_x = \frac{V_T}{r^2}\left[\cos^2\theta(r^2 - R^2) + \sin^2\theta(r^2 + R^2)\right] \qquad [13]$$

$$V_y = 2V_T \sin\theta \cos\theta \qquad [14]$$

V_x is the velocity causing rotation in the anemometer. Since V_y equals zero only if $\theta = 0°$ or $\theta = 90°$, theory indicates that velocity measurements should be made only with the anemometer along the x or y axes, if the component of velocity perpendicular to the direction of interest is to be eliminated.

Assuming that the operator is represented by a 1.5-ft diam cylinder, that the anemometer is held directly in front of the operator, and that the true air velocity is unity, Eq. 13 furnishes the relationship $\frac{V_x}{V_T}$ as a function of r, the distance between operator and anemometer. Curve A in Fig. 5 is obtained by this procedure. A comparison of curves B and C, derived from field data, with curve A shows conclusively that experimental results follow theoretical prediction.

In the preceding illustration, all values of $\frac{V_x}{V_T}$ are less than unity. Similarly, it can be shown that when the anemometer is held along the y-axis, the above ratio is greater than unity.

The theory of irrotational fluid flow fails when fluid turbulence is considered. The flow pattern around the body is then a function of body boundary form and roughness size and geometry, as well as Reynold's number. Discontinuities of flow originate at the body boundaries. At some critical velocity of approach the points of origin of these discontinuities

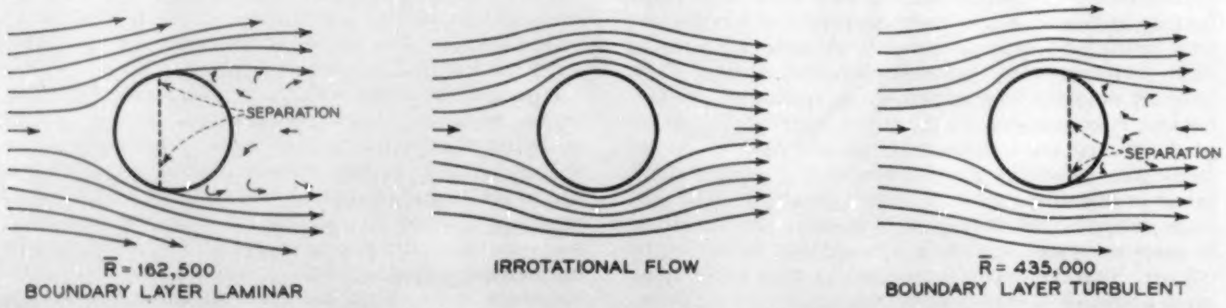


Fig. 6—The flow pattern around the body is a function of boundary form and roughness size and geometry, as well as Reynold's number. Discontinuities of flow originate at boundaries.

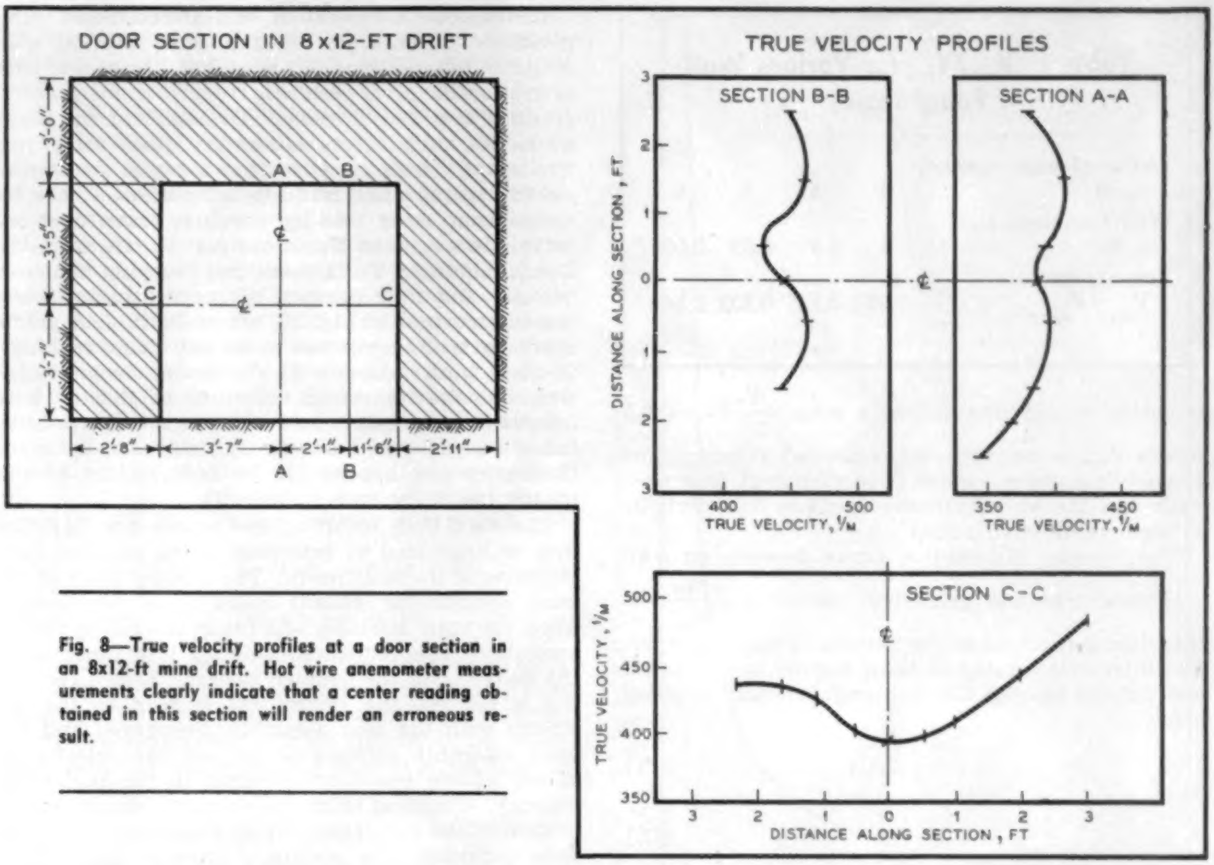


Fig. 8—True velocity profiles at a door section in an 8x12-ft mine drift. Hot wire anemometer measurements clearly indicate that a center reading obtained in this section will render an erroneous result.

suddenly jump from the upstream to the downstream side of the body, Fig. 6. Since at higher velocities the fluid tends to adhere closer to the body, the effect of velocity disturbances along lines perpendicular to the direction of flow is greatly reduced.

Operator Position: This change is clearly exhibited by the experimental curves shown in Fig. 7. These curves indicate that good practice should call for a minimum distance of at least 3 ft between operator and anemometer. At present, rules of thumb are used to compensate for errors resulting from operator proximity. To the authors' knowledge, none of these recognizes the influence of the magnitude of the true air velocity on the resulting error, or the influence of the anemometer location with respect to the operator. One such rule calls for subtraction of 4 sq ft from the gross area. In a 6x8-ft section this effects a correction of about 8 pct; in an 8x10-ft section, a correction of 5 pct. Present knowledge cannot justify blind use of this rule.

Surveying Procedure

The ultimate goal in underground air measurement is determination of air volumes, which requires specification of two quantities: area and average velocity. Mine openings are seldom of cross-sections that can be easily ascertained; wall irregularities, artificial support, chutes, and other obstructions interfere with correct evaluation. A high degree of accuracy in area determination demands special preparation of section, such as concreting or planking. This creates a permanent station and effects reliability of measurements. Expediency and section preparation costs often lead to choice of existing doors or regulator openings as convenient locations for air measurements. The behavior of the air current at such places should be understood before a dependable procedure can be evolved and reliable results obtained.

Location of Section: A door or regulator opening is an orifice. Therefore, the velocity distribution across these sections depends on such factors as the true air velocity, proximity of opening to the ribs, roof, and floor, and sharpness of the orifice boundary. The velocity measurements, Fig. 8, with a hot wire anemometer in a door section clearly indicate that a center reading obtained in this section will render an erroneous result.

Single Vs Multiple Readings: There are, in general, two procedures for determining velocity at a section: a single reading, usually made at the geometric center of the section, or multiple readings, i.e., traversing of the section, either in a continuous or intermittent manner. Single readings are employed in everyday work as spot checks on air circulation and are important to the ventilation engineer when compared on a day-to-day basis. The value of velocity obtained in such cases is presumed to be high and a correction is normally applied. The average velocity is assumed to be 0.8 to 0.85 of the registered velocity. A reference to Fig. 8 shows the possible error involved in using this method in combination with a poor choice of section. In addition, the validity of the correction factor is questionable.

The value of this factor depends on the shape of the velocity distribution curve, which in turn is related to Reynold's number and to wall roughness. Typical velocity curves in relation to Reynold's number are shown in Fig. 9(a). Using the British Engineering system of units, a Reynold's number of 2000 defines the upper limit of the laminar flow region in which the velocity curve is parabolic and independent of wall roughness. This parabolic dis-

Table I. V_{avg}/V_{max} for Various Wall Roughnesses				
Radius of mine opening: r_0, ft	5	5	5	5
Wall roughness size: e, ft	1	0.5	0.05	0.005
Velocity ratio: V_{avg}/V_{max}	0.694	0.725	0.802	0.845

tribution of velocity defines a ratio $\frac{V_{avg}}{V_{max}} = 0.5$ where V_{max} is the corrected registered velocity. For Reynold's numbers above 2000 turbulent flow prevails and the velocity curve assumes a hyperbolic or logarithmic distribution.

The velocity distribution curve depends on wall roughness size and geometry; the ratio $\frac{V_{avg}}{V_{max}}$ is therefore a function of the friction factor, Fig. 9(b). The inter-relationship of these factors, investigated and defined by von Karman and Prandtl,[8] is given below:

$$\frac{V_{max}}{V_{avg}} = 1.43\sqrt{f} + 1 \qquad [15]$$

$$\frac{1}{\sqrt{f}} = 2\log_{10}\frac{r_o}{e} + 1.74 \qquad [16]$$

where f is the friction factor, r_o the radius of the conduit, e the equivalent roughness size, and 1.74 a constant embodying shape. This constant does not change appreciably, being 0.88 for very wide open channels.

Assuming the above expressions to be true for square and rectangular sections, such as mine openings, the relationship between V_{avg} and V_{max} for varying wall roughness is given in Table I.

The tabulated results indicate that the factor 0.80 is based on a wall roughness of about 0.5 in. in a 10x10-ft drift. This factor cannot be expected to apply to the average mine opening. A factor of 0.70 to 0.73 may give a better estimate of average velocity in the usual mine opening. For a closely timbered section the value may approach 0.8.

Traverse Method: Errors inherent in the previous method of velocity measurement may be partially eliminated by using the traverse method. Traversing may be continuous or intermittent.

Consistency requires that traversing be done in a prepared section so that both velocity and area determinations may have equal dependability. The intermittent method of traversing involves evaluation of the mean of a number of individual velocity readings taken at the centers of subdivisions of the area of the mine opening. The accuracy of this mean is a function of the number of the subdivisions of area as well as the time interval of recording individual readings. The alternate method of traversing involves continuous surveying across the conduit section, due precautions being taken to insure a steady rate of instrument travel and a representative integration over the area of the section. Accuracy, by this method, is a function of the rate of instrument travel and the number and spacing of individual instrument swings.

Instrument Acceleration and Deceleration: Dependence of accuracy on the time interval over which individual readings are taken brings into consideration the error resulting from instrument accelerations and decelerations. To ascertain the magnitude of such errors laboratory tests were run. Preliminary tests revealed that a 2-min interval of velocity registration could be adopted as a base for comparison, since velocity readings taken over intervals in excess of 2 min did not deviate from the 2-min reading. Tests were run varying true air velocity and time interval of registration. Results are summarized in Fig. 10, where individual points represent averages of two to six individual readings. The test work indicates: 1) The deviations are negative, i.e., the registered velocities at shorter time intervals are higher than the registered velocity taken over a 2-min interval. 2) This error, for practical purposes, appears to be independent of the magnitude of the true air velocity.

The fact that resulting deviations are negative may be explained by reference to the physical construction of the instrument. The moving parts of the vane anemometer consist basically of two assemblies: the vane assembly and the gear-and-recording assembly. The registered velocity is a function of the behavior of the coupled system. Before recording is started, the instrument is held in the air stream with the gear assembly disengaged and the vane assembly rotating at an angular velocity in excess of the one corresponding to the registered velocity. Coupling of the two systems causes acceleration of the gear assembly and deceleration of the vane assembly. The inertia of the gear assembly is of a lower order of magnitude than that of the vane assembly. The ensuing large momentum impulse delivered by the vane assembly causes the latter to reach an angular velocity in excess of the one corresponding to the true air velocity. The period of adjustment depends on the relative inertias of the two assemblies and results in a deviation. This deviation loses significance as the time interval of registration increases. Fig. 10 is of value in suggesting that velocity readings at a point should not be taken over a period shorter than 20 sec, if the error is to be kept below 2 to 3 pct, and that accuracy demands a period in excess of ½ min.

Continuous Traversing: The curve in Fig. 10 does not exemplify the behavior of the instrument in the case of continuous traversing, where the two moving assemblies are coupled to each other while traversing takes places. The error in the reading will be a function of the response of the coupled systems to the rate of velocity change across the path of instrument travel. This behavior is exceedingly difficult to determine experimentally. In the authors' opinion, however, it is safe to assume that the order of magnitude of such deviations will be comparable, although of opposite sign, to those determined experimentally.

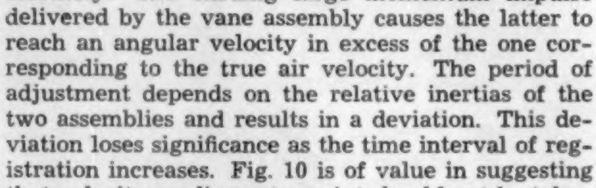


Fig. 9—Typical velocity distribution curves as a function of Reynold's number $\bar{R}$ and wall roughness.

An estimate of errors of instrument acceleration and deceleration in continuous traversing may be determined by assuming that measurements are made in a specially prepared concreted section where the velocity distribution curve is as shown in Fig. 9 ($\bar{R}>2000$). The errors may be attributed to the initial impulse when the moving parts are coupled at the start of the traverse and the subsequent response of the coupled system to velocity variations in the path of instrument travel. The error due to initial impulse may be neglected if the total time of traversing is greater than 1 min. If maximum velocity in the drift is 600 fpm, minimum velocity may measure an estimated 450 fpm. If the swing is made across the transverse center line of the drift in a ½-min interval, the instrument is exposed, in 15 sec, to a velocity variation of 150 fpm. The error may then be estimated from Fig. 10 to be about 3 pct or $150\times0.03=4.5$ fpm. Using a ratio of $\frac{V_{avg}}{V_{max}} = 0.85$, the average velocity in the drift will be $600\times0.85=510$ fpm. The percent error in the average velocity will then be $\frac{4.5}{510} \times 100 < 1$ pct.

Normally mine openings exhibit wall roughness of ½ to 1 ft. Such protrusions create numerous eddies and nonparallel flow along the boundaries, rendering velocity measurements in their vicinity of no value. Continuous traversing should be employed only in specially prepared sections.

Results and Conclusions

The results of the foregoing investigations and studies may be summarized as follows:

1) The manufacturer's calibration curve or chart accounts for the velocity deviations caused by the difference in response of the anemometer mechanism to varying true air velocities. These deviations may be positive or negative and vary with the physical condition of the instrument, necessitating occasional recalibration.

2) Deviations resulting from changes in atmospheric conditions increase with increasing density ratio and decrease with increasing true air velocity. They may be positive or negative and are, in general, insignificant.

3) For practical purposes, deviations resulting from anemometer inclination appear to be independent of true air velocity. They are always positive and may be neglected for instrument rotations up to 20°. Diligent procedure will eliminate errors from this cause.

4) Operator proximity to the anemometer gives rise to deviations which vary inversely with true air velocity and operator proximity. Good practice calls for a minimum distance of 3 to 4 ft between operator and instrument.

5) The nature of the deviations resulting from operator proximity are specified by operator position with respect to the anemometer. Theory indicates that velocity measurements should be made preferably with the instrument in one of two definite positions with respect to the operator: directly in front, the resulting deviations being positive, and directly to the side, the resulting deviations being negative.

6) Practical rules of thumb used to compensate for deviations resulting from operator proximity are, in general, not effective solutions to the problem. They do not distinguish the dependence of such deviation on the magnitude of the true air velocity and on operator position.

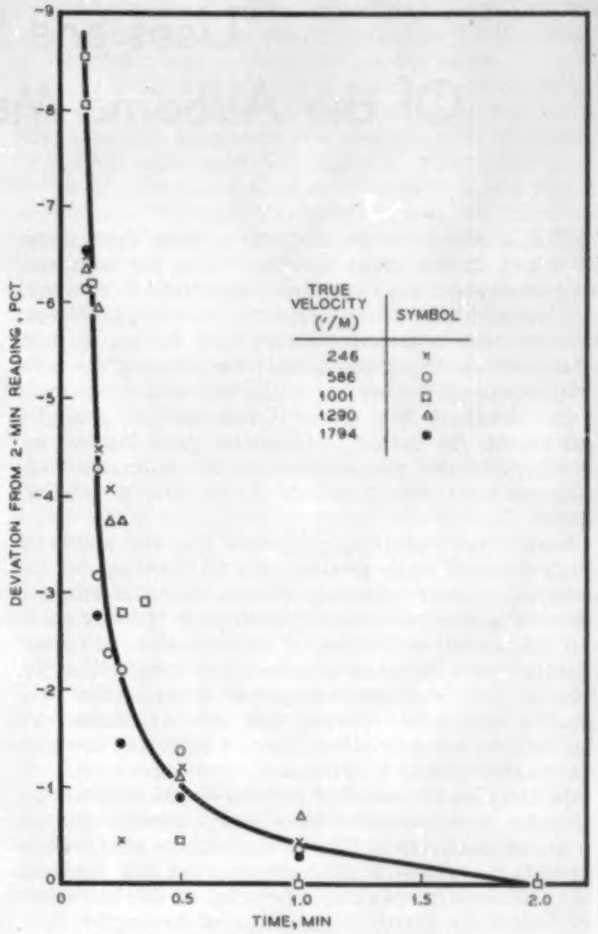


Fig. 10—Percent deviation from 2-min reading vs time of registration.

7) A door, regulator opening, or other orifice-type sections are poor choices of location if a single-reading determination of velocity is made and velocity distribution is unknown.

8) The correction factor normally applied to the single center-reading of velocity, to reduce it to a value of average velocity at the section, is a function of Reynold's number and the wall roughness size. Factors of 0.8 to 0.85 are seldom applicable to the common mine opening.

9) For practical purposes, the deviations resulting from anemometer accelerations and decelerations are independent of the magnitude of the true air velocity. It appears that good practice should require a minimum of ½ min for registration.

10) The response of the instrument tested indicated negative deviations in the case of intermittent surveys. It may be shown that if continuous traversing is employed in a specially prepared section and ample time for registration is allowed, deviations resulting from instrument acceleration and deceleration are insignificant.

References

[1] Cloyd M. Smith: Underground Anemometry. *AIME Trans.*, January 1949, vol. 184.

[2] E. Ower: *Measurements of Air Flow.* Chapman and Hall Ltd., London, 1933.

[3] H. Rouse: *Elementary Fluid Mechanics.* John Wiley & Sons, Inc., New York, 1946.

[4] S. Boshkov and B. Amontree: How Proximity of Operator Affects Anemometer Readings. *Engineering and Mining Journal*, May 1950, and *Coal Age*, May 1950.

Uses and Limitations Of the Airborne Magnetic Gradiometer

by Milton Glicken

THE airborne geophysicist is a busy man these days. In his plane he may have the airborne magnetometer, the airborne scintillation counter, and the airborne electromagnetic surveying system. Each of these is an independent tool, but all require additional auxiliary equipment for locating the aircraft in space: recording altimeters and Shoran or aerial cameras. Now there is still another piece of equipment, the airborne magnetic gradiometer, an accessory to the magnetometer. To understand its uses, consider the function of the magnetometer itself.

Aside from detecting magnetic ore, the airborne magnetometer finds greatest use in spotting intrusions of igneous material. Where there is enough contrast in magnetic susceptibility of igneous rock and adjacent formations, it outlines the intrusion. Certain minerals also influence the magnetometer directly, but with the exception of magnetite and possibly one or two others, their effect is weak and can be detected only when there is sufficient ore and the magnetometer flight passes very close to it.

An igneous intrusion of infinite depth with vertical sides is represented on a magnetometer record by an anomaly, as in Fig. 1. Amplitude of the high depends on susceptibility contrast of the igneous rock. Generally speaking, the edge of the intrusion lies below the point of inflection of the curve, and this point, where the curvature changes from positive to negative on the magnetometer profile, would be near *A* in Fig. 1, with a counterpart, of course, on the other side. Location of the contact is one of the principal objects of the survey, but finding the precise point is not always easy, as inspection of the curve near *A* will show.

Mineralization is often found at the contact zones, as at *B*. Magnetic effects, if detected, may be small, as in *B'*, and when superimposed on the anomaly due to the instrusion they are very difficult to discern and analyze. Furthermore, if these small fluctuations are to be perceived by the magnetometer the vertical scale should be large. This increases the slopes of the anomaly and makes detection of small deviations and inflection points even more difficult.

The airborne magnetic gradiometer was designed to help overcome these difficulties. What it presents is the first derivative of the magnetometer record with respect to time, that is to say, the slope at any point. Fig. 2 represents an actual magnetometer record (solid line) with the corresponding gradiometer record (dashed line) superimposed. Both records read from right to left. Vertical lines on the original magnetometer record are automatic steps designed to keep the pen from going off scale. The slope of any curve is greatest at the point of inflection or point where the curvature changes sign, and this point is a maximum (or minimum) on the gradiometer. The chief advantage of the gradiometer is that maxima or minima are much easier to see and to locate precisely; hence an accurate location for the point of inflection can easily be found. Note that points *C* and *D* are more sharply defined than *C'* and *D'*.

M. GLICKEN is associated with Fairchild Aerial Surveys, Inc., Los Angeles.

Discussion of this paper, TP 4045L, may be sent (2 copies) to AIME before Jan. 31, 1956. Manuscript, Feb. 28, 1955. Chicago Meeting, February 1955.

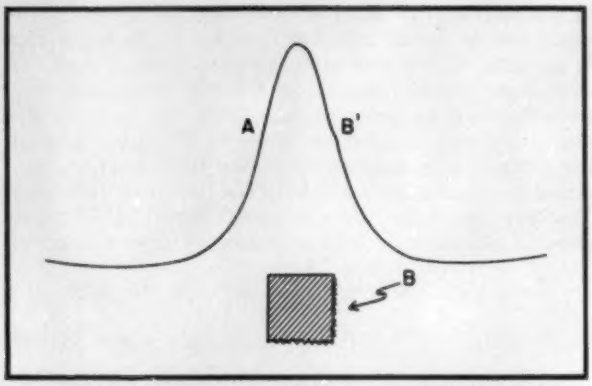


Fig 1—Typical magnetic anomaly due to orebody, showing point of inflection somewhere near *A* and magnetic effect *B'* of mineralized zone at *B*.

Similarly the small fluctuations of the original record, so important to the interpreter, are far more clearly shown at *E*, *F*, and *G*, than on the original record at *E'*, *F'*, and *G'*. Though not necessarily highs and lows on the gradiometer, they do show up clearly what would take a painstaking analysis to detect on the original magnetometer record.

Will the gradiometer have a particular configuration which indicates an orebody? Not necessarily. The total intensity curve, or original magnetometer record, can display an orebody in various ways, depending on dimensions, orientation, latitude, and composition, as well as on direction, flight height, and instrumental sensitivity of the traverse. Where the total intensity can take on so many different shapes the gradiometer must vary too. It is generally recognized that interpretation of total intensity magnetometer records requires an expert analysis; the gradiometer can be of considerable assistance to the expert but it does not replace him.

Mechanism of the gradiometer is simple. A Leeds & Northrup recorder in the aircraft records the magnetic gradient simultaneously with the total intensity, which is on another recorder. Fiducial marks are put on both records simultaneously and the speed of the paper through the recorders is kept the same on both. This makes it possible to place one record over the other for direct comparison.

In the laboratory the flights are positioned on a map. Maximum and minimum points on the gradiometer, which can then be posted on the map at their proper locations, may be expected to fall along a trend crossing the direction of flight. Trends should indicate the edge of an intrusion, or some other important features, and when superimposed on the total intensity contour map help greatly to locate the points of inflection, or line of zero curvature.

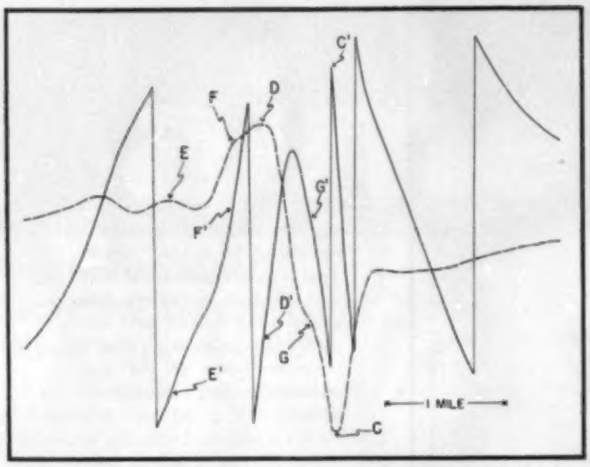


Fig. 2—Sample total intensity magnetometer record (solid line) and corresponding gradiometer record (dashed line).

It might logically be asked whether a contour map of the gradiometer readings would be of value. It is common practice, of course, to draw a contour map of total intensity readings from the original magnetometer records. The contours then make it possible to examine a section in any direction—not necessarily the direction of flight—and obtain information about the magnetic field in that direction, giving a profile equivalent to that which would result from a flight having been made there. The gradiometer, however, gives the slope of the total intensity record *in the direction of flight only*. Therefore a cross-section through a gradiometer contour map in a direction other than that of the line of flight would have no physical significance.

This point brings up another. It has been suggested that a first derivative of the gradiometer record itself would yield what might be called a second derivative and that this could replace the present second derivative or curvature maps which are laboriously computed in the laboratory. However, the same shortcoming would apply, that is, the standard curvature map results from examining the *neighborhood* of every point on the map and therefore results in a contour map which represents the true curvature of the potential surface. The electronically derived second derivative, made in flight, necessarily represents the curvature in the direction of flight only and is therefore not the same.

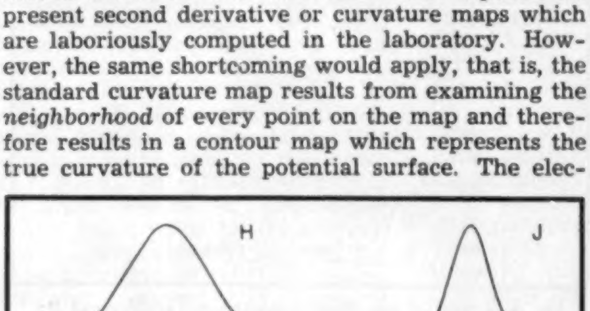


Fig. 3—A magnetic anomaly, (*H*), compressed laterally when flown faster (*J*), will give gradiometer curves of different amplitudes (*H'* and *J'*). When flown in opposite directions (*K* and *L*) the gradiometer records will be reversed in sign (*K'* and *L'*).

Fig. 3 illustrates two precautions to be taken in analyzing gradiometer records. Curves *H* and *J* are total intensity magnetometer records over the same anomalous structure, but flight *H* was made at a slower ground speed than *J*. Inasmuch as the speed of the paper through the recorder was the same on both, the anomaly was spread out over a longer time interval on *H* than on *J*. But note that at any given point on the ground the total intensity readings would be the same on both flights. Now consider *H'* and *J'*, the respective gradiometer records; the maximum slope on *J* was greater than the maximum on *H*; therefore the amplitude of the maximum point on *J'* will be greater than that on *H'*, although the ground location will of course be unaltered. Obviously it is unwise to draw any inferences from the size of the peaks on the gradiometer records unless some correction is made for ground speed. All this, of course, is due to the fact that the gradiometer records the first derivative with respect to time, rather than to distance, but the readings could be restored to a common datum by multiplying by the reciprocal of the ground speed of the aircraft.

Fig. 3 illustrates one more interesting precaution. *K* and *L* are total intensity records flown in opposite directions over the same anomalous situation, one westbound and the other eastbound. *K'* and *L'* are their respective gradiometer records, one showing a minimum and the other a maximum. To eliminate the effect of the reverse direction multiply one of them by -1. This correction could be incorporated in the previous one by applying an appropriate sign to the ground speed of the aircraft.

These corrections to the gradiometer record which must be made because the record is on a time scale could possibly be avoided, along with the cost of additional aircraft installation and instrumentation, by having a derivative curve made up in the laboratory by clerical means. But the advantages of having a continuous, complete record, free of human errors, available as soon as the aircraft lands, outweigh the disadvantages.

Use of the gradiometer is shown by three profiles, Fig. 4, across the Short Line orebody, an open pit

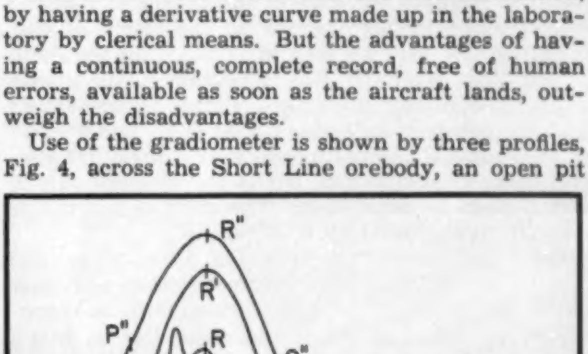


Fig. 4—Three total intensity magnetic profiles over the Short Line orebody, Utah. The magnetite itself, drawn to scale, is indicated by the arrow.

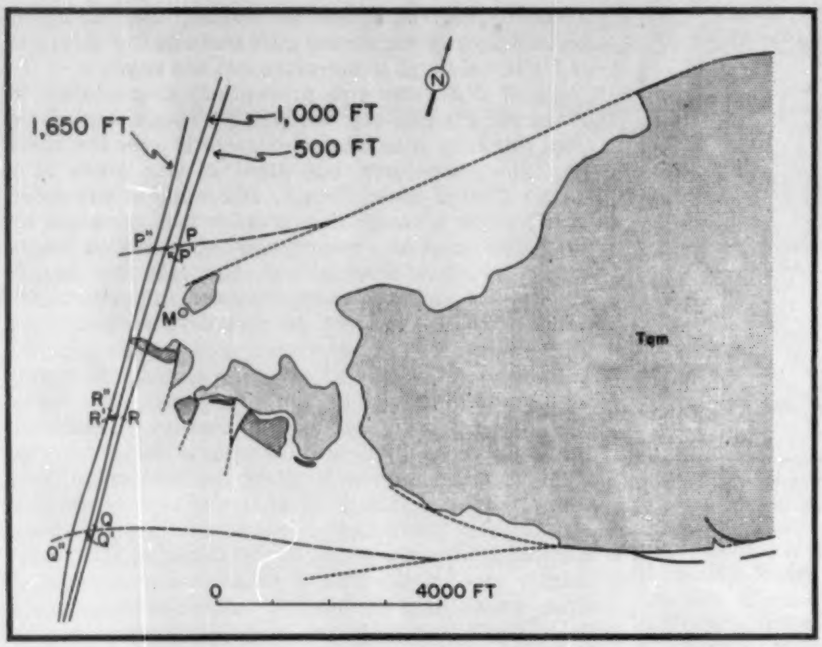


Fig. 5—Simplified geology of vicinity of Short Line orebody. *Tqm* is quartz monzonite. Diagonal shading represents magnetite. Long dashed lines show postulated location of edge of intrusion, based on the magnetometer and gradiometer records.

magnetite mine in southwestern Utah operated by Columbia-Geneva Steel Co. The three magnetometer records were flown at 500, 1000, and 1650 ft, respectively, and the orebody itself is shown at the end of the arrow in a size relative to the scale of the total intensity records. It is obvious that the major anomaly in the two upper profiles could not come from the orebody itself; it is probably caused by association of the orebody with an intrusion of quartz monzonite. The problem is to define the edge of the intrusion.

From ground magnetometer surveys run by Cook during 1944 and 1945, there seemed to be a small magnetic low on the ground, and this has been supposed to indicate the edge of the intrusion. On the lowest magnetometer record an indication of this magnetic low may be seen at point *M* on the flank of the large anomaly. But inspection of the gradiometer records for these three flights clearly shows that the points of inflection are at *P*, *P'*, and *P"* and at *Q*, *Q'*, and *Q"*. The flight at lowest level has several other critical points, but at the moment only *P* and *Q* need be considered. The crest of the major anomaly is indicated by *R*, *R'*, and *R"*.

On a plan view of the area, Fig. 5, the three profiles lie not quite directly over each other and their paths are shown. The quartz monzonite is represented by stippling, while the magnetite is shown by diagonal shading. J. Hoover Mackin, whose geologic map has been used for this figure, has postulated the faults that bound the intrusion to be shown by the short dashed lines, but it is reasonable to assume that they might be at the long dashed lines, going through the points of inflection of the large magnetic anomaly. Thus the gradiometer has assisted in giving the probable location of the edge of the intrusion, and therefore the zone of greatest interest.

Fig. 6 shows local anomalies on the lowest-level profile, which is enlarged in horizontal scale, with a geologic section underneath. Symbols for magnetite and quartz are the same as on Fig. 5, and the gradiometer record is superimposed as a dashed line. Point *R* corresponds to the maximum point on the other two magnetometer profiles. Point *S* might very well be due to the orebody itself. The large amplitude could be due to high susceptibility contrast or to a large mass of material, but the absence of this anomaly 500 ft higher indicates that it comes from something small and close to the surface, hence the conclusion that it is probably due to susceptibility contrast. Anomaly *T* could very well be worth

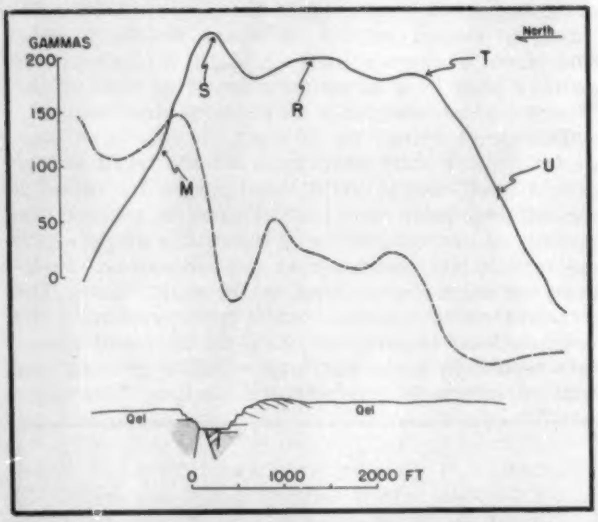


Fig. 6—Lowest of the three magnetometer profiles and its corresponding gradiometer record. Anomaly *T* suggests further geologic study; its point of inflection is at *U*.

further investigation. As an aid in such investigation, location of the point of inflection of this anomaly has been determined from the gradiometer record and is shown at *U*.

To summarize, although the gradiometer is not an independent instrument and is limited in quantitative applications, it helps the interpreter locate and study contact metamorphic deposits and certain types of anomalies commonly encountered in mining. It is worth consideration in planning a magnetometer survey.

Acknowledgments

The author wishes to thank Columbia-Geneva Steel Co. for permission to use the geologic cross-section of the mine and Fairchild Aerial Surveys Inc. for use of its facilities in preparing this paper.

aime news

Engineers Honor Secretary Wilson With Washington Award

Charles Erwin Wilson, Secretary of Defense, has been selected to receive the internationally recognized Washington Award in 1955 for his "significant leadership in engineering and management and for his altruistic devotion to national defense."

The Washington Award is sponsored by the American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, and American Society of Electrical Engineers and is administered by the Western Society of Engineers of Chicago. Since the award was founded by John W. Alvord in 1916, an engineer has been selected each year whose contributions to society have gone far beyond the fields of engineering and science. The first recipient of the Award in 1919 was Herbert Hoover and in 1954 Mrs. Lillian Gilbreth was selected.

As an assistant to Carl G. Lamme, chief engineer at Westinghouse, Charles Wilson became interested in the automobile electrical equipment work at Westinghouse and was placed in charge of this phase of the business. During World War I he was sent to Washington and designed and developed radio generators and dynamotors for the Army and Navy. He also developed a primitive crystal set, granddaddy of the walkie-talkie for the infantry and a little generator designed for wing mounting on the 1918 planes. He also designed the electrical equipment for the Army's "B" truck.

This experience led him into the Delco-Remy Co. where he made many contributions to the development and production of automotive electrical and ignition systems and from this to a position where he headed the entire group of General Motors accessory companies. His outstanding work as an engineer and administrator ultimately landed him in the top executive post of General Motors.

Charles Wilson has exerted a tremendous influence in improving the relations between management and labor. His "escalator" clause in long-term labor contracts and his "improvement factor" to increase labor's share in technological improvements changed the national thinking on labor relations.

Don't Forget!

1956 Annual Meeting

When: February 20 to 23

Where: Statler & New Yorker Hotels, New York City

Advance program report appeared in MINING ENGINEERING, October issue. A more detailed story will appear in the December issue.

TPC Names Members

The following have been appointed to the AIME Technical Publications Committee for the year beginning Oct. 15, 1955: N. Arbiter, Chairman; J. R. Atkinson and W. R. Hibbard, Jr., Vice Chairmen; E. J. Kennedy, Jr., Secretary; J. A. Ames, S. Boshkov, S. J. Dickinson, H. B. Emerick, F. B. Foley, G. H. Hazen, Evan Just, C. H. Lambur, E. P. Lange, Mord Lewis, A. R. Merz, and F. L. Vogel. This committee is the final authority on the acceptance of Transactions paper, guiding its actions by the recommendations of Divisional Publications Committees.

MIED To Have Award

To recognize originality and leadership in teaching, and administrators who contribute materially to the advancement of mineral industry education, the Mineral Industry Education Div. has set up a Mineral Industry Education Award. A prize of not less than $100 together with a suitable certificate of award is planned. A committee to select a suitable recipient for an award to be made at the forthcoming annual meeting has been named as follows: C. E. Lawall, Chairman; Allison Butts, '59; H. H. Power, '58; C. H. Behre, Jr., '59; and C. L. Wilson, '60. Income from a small principal fund collected several years ago will be used to finance the award.

Ballots on Name Change Sent Members

Changing the name of the Institute to "American Institute of Mining, Metallurgical, and Petroleum Engineers, Incorporated," was unanimously voted by the Board of Directors at the Annual Meeting. As this involves a change in the Constitution and in the Certificate of Incorporation, various lengthy formalities are involved. Among these is the sending of a ballot to all members asking for their approval of the change. These ballots were mailed late in September and were to be returned to the Secretary of the Institute by the second Tuesday in November. If the vote supports the change, the matter will presumably be brought up at the annual business meeting of the AIME Feb. 21, 1956, after which, if all necessary actions are favorable, the new name will become established. Many changes will be necessary, such as in letterheads, seal, medals, and certificates, but it is intended that the abbreviation will continue "AIME" as before.

New Director Named

At the recent AIME Board meeting, Charles R. Kuzell was named to succeed E. L. Oliver, deceased, for the latter's unexpired term as AIME Director, until February 1956. Mr. Kuzell's regular term as Director for three years begins at that time.

Rocky Mountain Minerals Conference

W. W. Mein, Jr., addresses the Salt Lake City meeting.

It caught them coming (from the Black Hills) and going (to Las Vegas)

The Second Annual Rocky Mountain Minerals Conference sponsored by the Utah Section of the AIME was held at the Newhouse Hotel, Salt Lake City, October 6, 7, and 8. The meeting was also the MBD Fall Meeting. Fine, clear weather greeted representatives of the western states mining industry, as well as the many visitors from the East, as they gathered together to take part in a three-day session of technical papers, renewed friendships, field trips, and fun.

Chefs at the Scotch Breakfast of the Minerals Beneficiation Div. at Salt Lake City are, left to right, N. L. Weiss, W. L. Dowdey, E. H. Crabtree, Jr., R. C. Cole, Will Mitchell, Jr., and W. B. Stephenson (sitting).

A Visitor's Reactions

Have you ever had two jiggers of scotch in your oatmeal? Some of us are still reminiscing over the super Scotch Breakfast put on by the MBD at the Rocky Mountain Minerals Conference in Salt Lake City. After a while, even the mournful wail of the bagpipes seemed almost bearable.

It is impossible to completely discuss or report on all events of the meeting held in Salt Lake City in October—especially since there was something of interest for all facets of mining. Among the highlights was a fiery and energetic speech by Governor J. Bracken Lee of Utah. Authoritative papers on milling problems, control engineering, and uranium activities were presented by such people as Carl M. Marquardt, Ernest T. Thurlow, Clem Chase, F. E. Briber, Jr., and John S. Wright, Jr. We also enjoyed the interesting discussion on problems of greater cooperation among geologists and metallurgists for metallurgical planning. Some miner reminded us that geologists and metallurgists were just "sheepherders with their brains kicked out" so we just tightened our bow tie and kept smiling, meanwhile planning to push him off the railway cars when inspecting the Bingham mine the next day. The Bingham field trip provided an opportunity to learn how some 90,000 tons of ore and over 160,000 tons of waste are moved daily.

Left to right: S. D. Michaelson, E. W. Engelmann, Donald W. Scott, John F. Myers, Grover Holt, and Edwin H. Crabtree, Jr.

The tour included a visit to the Lark mine and ground plant where John Holmes, a mining superintendent for the U. S. Smelting & Refining Co., supplied a picture of safety activities. This is one of the most modern surface plants in the West and the U. S. Smelting & Refining people are most proud of a new record at Lark mine of six months' continuous operation without a lost time accident. This is something of a record for an operation that employs 750 men underground. One of

the most impressive sights in the plant is a display of safety goggles damaged in mine accidents. On this safety glass board each of the goggles is fastened with what remains of the shattered lens and a card describing the accident and the name of the man who was protected. There is a tremendous interest in the safety and welfare of the men at this operation.

One of the features of the surface plant at the Lark is a fuse shed where one man machine-cuts standard lengths of fuses, crimps caps, and binds the fuse in short twist bundles of 25. This not only saves time and man effort underground, but represents an added safety feature. Mine timber is cut on the surface in a modern one-man mill. Formerly six or seven men might have been employed to cut and size the timber and the timber mill operation alone saves some $30,000 per year. Another example of the U. S. Smelting & Refining line of progressive thinking was noticed—there are six geologists on the 30-man headquarters staff.

Left to right, E. O. Kirkendall, A. Buzzalini, E. H. Robie, and R. E. O'Brien represented the AIME Staff at the Salt Lake City meeting.

Technical Sessions

Seventeen technical papers and a symposium were the technical fare spread over three days for the visitors. Attendance at the various sessions ranged up to 180, and the symposium on Saturday morning drew about 225. This session produced a great deal of discussion on the methods of getting members of the mining and metallurgical team to cooperate with one another. Speakers from the audience cited examples of methods used to achieve this goal. A surprising amount of emphasis was placed on the need for micrographic study and research.

Thursday Luncheon

At the luncheon Thursday, attended by some 325 persons, out-of-state members were welcomed to Utah by the Hon. J. Bracken Lee, Governor of Utah. The Governor spoke of the drift toward government by man from government by law in an address that drew nationwide press comment. The people of the United States, he said, are in grave danger of losing their rights and privileges as guaranteed by the Constitution. He cited several instances of Federal and local government encroachment upon individual rights.

During the luncheon meeting persons who made the conference possible through their efforts were introduced and acknowledged before the gathering. Local and national officials of AIME were also introduced.

One of the social features of the Salt Lake meeting was the Dinner Dance on Saturday night with an *imported* band for the occasion. Salt Lake AIME members have a special knack for royal entertaining and among the proud and jolly hosts we are pleased to note the guidance of Mr. and Mrs. Neil Plummer, Mr. and Mrs. Roger Pierce, Mr. and Mrs. Richard Cole, Mr. and Mrs. Norman Weiss, Mr. and Mrs. Jack Ehrhorn, Mr. and Mrs. Stan Michaelson, and Mr. and Mrs. Ray Thompson.

Field Trips

Winding up the meeting was a full roster of field trips. The seven tours were: Geneva Steel Works, Bingham and Lark mines, Magna and Arthur mills, Garfield Smelter and Refinery, Western Phosphates plant, Vitro uranium mill, and the Kennecott Research and Engineering Center.

First-class planning and execution marked the committee work for the Rocky Mountain Minerals Conference. Rather than mention a few names and fail to list other equally hard working committeemen we simply say: the meeting itself showed the results that can be obtained with careful planning and devoted interest to the responsibility of each task.

* * *

(The Editors of MINING ENGINEERING wish to thank Henry R. Fletcher of the Utah Section, and Arnold Buzzalini, AIME Mining Branch Secretary, for supplying the material for this story of the conference. Credit is also due to Norman Weiss, MBD Associate Chairman, and Roy E. O'Brien, AIME Field Secretary, for providing the photographs of the meeting.)

Name AIME ECPD Representatives

AIME representatives on the Engineers' Council for Professional Development for the year beginning Oct. 14, 1955 have been named by the Board as follows: Committees: Guidance, M. D. Cooper and F. T. Sisco; Education, L. E. Shaffer and J. R. Van Pelt, Jr.; Student Development, C. L. Wilson; Training, R. J. Schilthuis; Recognition, F. C. Breyer; Information, A. S. Cohan; Ethics, Clyde Williams. Also R. F. Baker has been named to succeed T. A. Read as AIME representative on the Council itself, for a three-year term expiring in October 1958. The other two representatives are J. P. Nielsen and E. P. Lange.

Raymond Award Receives Bequest

The estate of the late Arthur S. Dwight, President of AIME in 1922, has given the Institute $551.65 to be added to the principal of the Rossiter W. Raymond Fund. The principal of the fund now amounts to approximately $6500. Income is used to finance an annual certificate for the best paper published by a member of the Institute under 33 years of age, and from now on the sum of $100 will also be awarded.

Dallas To Be Host For 1963 Annual Meeting

Formal acceptance has been given to the invitation of the Petroleum Branch to have the Annual Meeting of the AIME in Dallas, Feb. 17 to 22, 1963. As already announced, the 1957 meeting will be held in New Orleans, San Francisco in 1959, and St. Louis in 1961. In even-numbered years the meeting is held in New York.

Part of the group at the Black Hills regional meeting banquet. More than 200 people attended the banquet and dance. *Rapid City Journal Photo*

Black Hills Meeting Draws a Crowd

The Rapid City meeting was just about the best planned and managed meeting of its size the writer has ever attended. We were met at the airport by part of the official welcoming and taxiing committee. Registration at convention headquarters in the Alex Johnson Hotel preceded a trip through the Homestake mine and mill. The well managed mine trip allowed inspection of the lower levels of the mine workings down to the 3500-ft level.

At each of the stops in the mines we received demonstrations of the equipment being used and countless questions were capably answered by members of the Homestake staff. One of these men was R. H. Oitto, Jr., a third generation Homestake man.

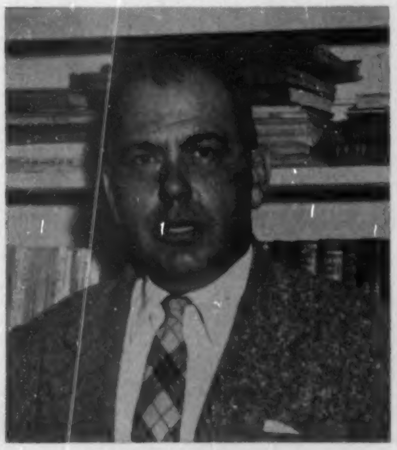
Sunday evening we were entertained royally at an outdoor western barbecue and the bow tie worn by your Mining Branch Secretary didn't feel so quite out of place as it did down on the 3500-ft level of the Homestake mine. The hosts for the barbecue party were the management staff of the Homestake Mining Co. represented by Mr. and Mrs. Guy N. Bjorge, Mr. and Mrs. A. H. Shoemaker, Mr. and Mrs. William Campbell. After the barbecue and campfire, which was closely surrounded by the crowd in the cool air of the Black Hills, we adjourned to the club house and enjoyed a play entitled "The Trial of Jack McCall." Among the members of the jury on the stage were Ed Robie, "Tommy" Mein, and Charlie Merrill.

Some of the highlights of the technical sessions conducted at the South Dakota School of Mines were talks on "Geology of the Black Hills," by E. L. Tullis; "The Homestake Mine Geology," by A. L. Slaughter; "The Pegmatites of the Black Hills," by Jack Redden, J. J. Norton, D. M. Sheridan; "Gold Mining Problems," by Guy N. Bjorge; and "Minerals of the Missouri River Basin," by John H. East, Jr. J. V. N. Dorr was scheduled to present a discussion on the "History of Gold Metallurgy," but was unable to attend due to illness. He was capably represented by John Grothe of Dorr-Oliver Inc., who also presented a most interesting and amusing talk to the AIME Student Chapter in the new and ultramodern mining technology building on the campus. There were many other fine discussions and papers presented at these meetings and the committee should receive a lot of credit for assembling this interesting program. —*A.B.*

Below and to the right are the men responsible for this top-notch meeting—the Committee Chairmen.

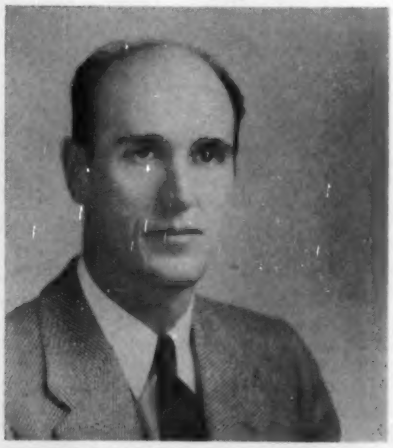
JOHN GRIES, Field Trips

NATHANIEL HERZ, MBD Program

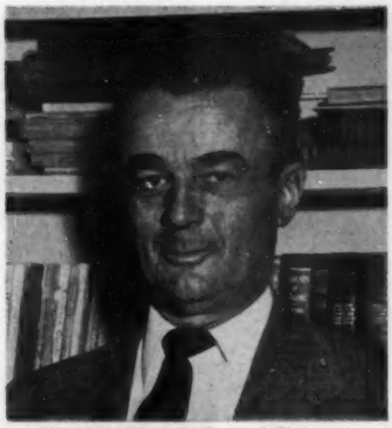


EDWIN OSHIER, Housing

PAUL ANDERSON, Publicity



TED RIZZI, Geophysics Program

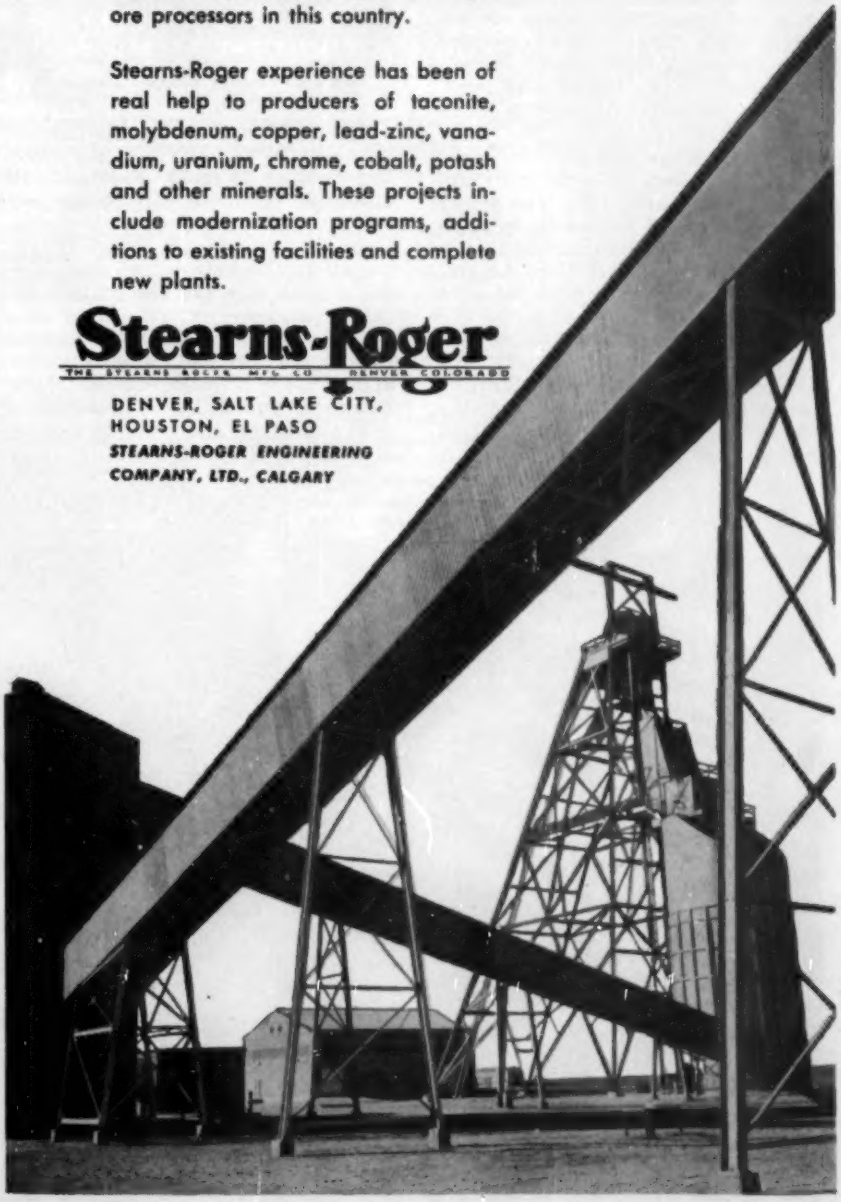


EDWARD TULLIS, General Chairman

ARTHUR RICE, Finance

JAMES HARDER, General Program

A. E. McHUGH, Convention Facilities

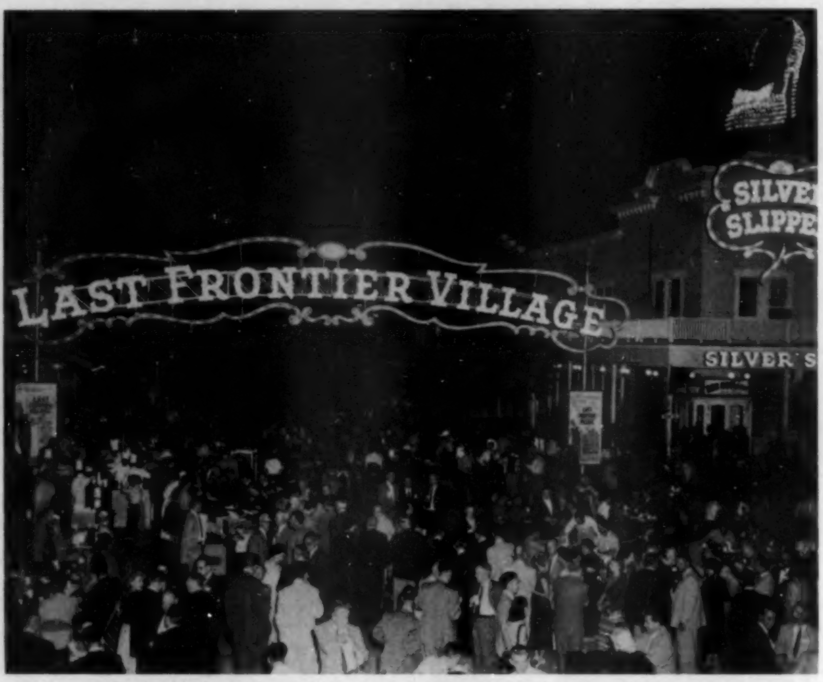


Mining Congress Meets In Fabulous Las Vegas

Holding the American Mining Congress in Las Vegas this year was an experiment, but attendance of more than 3200 men and women—some 50 pct greater than any former non-show meeting of AMC—indicated the selection to be a good one. Further proof was seen in the fact that the technical sessions drew almost capacity audiences.

Doubtless curiosity to see what Vegas is like attracted a good proportion of those who were there for the first time, as was the case with your reporter. It is not a place that we would pick for a vacation, but certainly everybody should see it at least once and spend a day or two there. The city now has some 50,000 population. To the south beyond the city limits, on either side of the broad highway for 2 miles is The Strip. Bordering the highway are ten hotels, many motels, and a few shops and restaurants. Hotel rooms are satisfactorily large, clean, and well equipped, and the restaurants serve good food.

The tariffs are not high for what one gets. Talent of the type presented in the night club type shows is expensive and the hotels hope to pay for it in considerable part by the profits from gambling. But we understand that the take from the mining men was disappointing to the hotels. Too much time taken up with technical sessions, eating, watching the entertainment, and visiting among themselves. Miners probably get all the gambling they want in their own profession.



One social highlight of the Mining Congress was the barbecue and western party at the Last Frontier Village, October 10.

The 18 technical sessions extending over the three days of the meeting, October 10 to 13, were all well attended. Uranium was the subject of four of the sessions, with discussions covering many phases of exploration, development, mining, milling, AEC policy, and the outlook for the industry.

Tariffs and taxation, national policies in the mining industry, labor and management problems, public relations, public lands, stockpiling, gold and silver, and markets took up almost half of the program.

Sessions on milling, metallurgy, exploration, geology, mining methods, and on new equipment rounded out the program. Two field trips took up the final day of the meeting. One was the rare earths mine and mill of the Molybdenum Corp. of America at Mountain Pass, Calif., 60 miles away. The other field trip went to the Henderson, Nev., area where wad ore is mined at the open pit of the Three Kids mine.—*E.H.R.*

ABOVE: Left to Right, L. C. Campbell (1954 Erskine Ramsay Medalist), Lt. Governor Rex Bell of Nevada, and Charles A. Steen chat at the Congress. LEFT: Ladies get-acquainted luncheon was at Hotel Riviera.

Around the Sections

• Instead of holding a monthly luncheon meeting in September, the **Lima, Peru, Section** took up an invitation from the Woman's Auxiliary for a barbecue at the Granja Azul in Santa Clara. The menu sounded wonderful.

• On September 14 the **San Francisco Section** heard J. C. Kinnear, Jr., speak at the dinner meeting. Mr. Kinnear, general manager of the Nevada Mines Div. of Kennecott Copper Corp., discussed production of copper from the Robinson Mining District, Ely, Nev. Slides supplemented the presentation. On October 5 the section heard Paul Henshaw speak on uranium prospecting at a meeting presided over by James P. Bradley. Attendance was 95. The November meeting will be sponsored by the student group of Stanford University.

• The **St. Louis Section** held its annual field trip in conjunction with the October meeting. The visit this year was to the Pittsburgh Plate Glass Co. plant No. 9 at Crystal City, Mo. The sand mine there has mechanized underground operations supplying the plate glass plant. The meeting was well attended by students from St. Louis and Washington universities. The November meeting will be held at the York Hotel in St. Louis. C. Kremer Bain will speak on shaft sinking.

• The October meeting of the **Washington, D. C., Section** featured Roscoe A. Cattell, chief, Div. of Petroleum, USBM, speaking on "Oil in Europe and the Middle East." Mr. Cattell recently completed an extensive trip through oil fields in Europe and Asia.

• The **Upper Peninsula Section** held its 1955 annual meeting at Ironwood, Mich., on September 24. Members attended from Houghton, Calumet, Ahmeek, White Pine, Freda, Laurium, Lake Linden, Ishpeming, Negaunee, Iron River, Hurley, and Duluth. The morning was taken up with a visit to the surface plant of the Peterson mine of Pickands, Mather & Co. Luncheon was at the Gogebic Country Club. Following the meal, Acting Chairman R. F. Moe of White Pine, Mich., introduced Ted Counselman, AIME Vice President, who had come from New York to attend the meeting.

The Upper Peninsula Section elected the following officers: R. F. Moe, Chairman; Burton H. Boyum, Ishpeming, Mich., Vice Chairman; and Roy W. Drier, Houghton, Secretary-Treasurer (re-elected).

• October 1 and 2 marked a two-day meeting of the **Montana Section.** Saturday evening dinner at the Club Rocco, Hungry Horse, Mont., was followed by a symposium program on the Anaconda Aluminum Co. plant. The speakers for the symposium included James F. Smith, production superintendent, Edwin Woster, potline superintendent, Donald J. McMaster, casting superintendent, and Harrell W. Kanzler, electrical maintenance superintendent.

The meeting also served to welcome William W. Mein, Jr., AIME Vice President, who spoke to the group. On Sunday the group took an inspection trip through the new Anaconda Aluminum plant at Columbia Falls.

PERSONALS

T. A. CAMPBELL

Thomas A. Campbell was awarded the Order of Merit in the rank of Knight Commander of the Order of Bernardo O'Higgins by **Enrique Bustos,** Consul General of Chile, on September 28 at the Chilean Consulate in New York. This award is given to "illustrious foreigners" who have a special affection for and have lent a service of value to Chile. Mr. Campbell is executive vice president of Chile Exploration Co., New York. He joined the company in 1925 as chemist and metallurgist in Chuquicamata, Chile, and became general manager in 1941. In 1946 he was made vice president and came to New York. Mr. Campbell returned to Chile in 1948 as vice president and managing director of Chile Exploration Co. and Andes Copper Mining Co., Santiago. He became executive vice president for both companies in 1952 and came back to New York. Mr. Campbell is also president, Chile Steamship Co., vice president, Chile Copper Co., Andes Exploration Co. of Maine, and Potrerillos Ry. Co., and a director of several Chilean companies. He was graduated from Yale University in 1919.

Padraic Partridge has joined Minerals & Chemicals Corp. of America, Menlo Park, N. J. Mr. Partridge was formerly with Filtrol Corp., Los Angeles.

Brinton C. Brown has joined the mining staff of U. S. Gypsum Co. and is at present located in Midland, Calif. Mr. Brown was formerly manager, Papago Mining & Milling Co., Tucson, Ariz.

Elwood B. Nelson has been appointed general manager, Coal Mining Div., U. S. Steel Corp. Mr. Nelson started with U. S. Steel 26 years ago as a coal washer engineer. He has held various positions with the company and was made chief engineer for raw materials in October 1954.

N. Garanis is mining engineer for the Mykonos Barite Co., Mykonos, Greece.

Oliver Bowles, mining and geological consultant, Washington, D. C., completed a special assignment with the U. S. Bureau of Mines in June. Since then Mr. Bowles has been working in Puerto Rico and in Quebec.

Sv. Aa. Kock-Petersen, division sales manager, F. L. Smidth & Co., New York, has returned to the company's office in Copenhagen, Denmark.

William A. Brewer is assistant geologist, Chile Exploration Co., Chuquicamata, Chile. Mr. Brewer was graduated from the University of California in June with an M.A. degree in geology.

F. Everard is filtration engineer, Eimco Corp., at the new filtration office in Toronto. Mr. Everard was assistant chief metallurgist, National Lead Co., St. Louis Smelting & Refining Div.

George Emery Guidry of Kerr-McGee Oil Industries Inc. has been transferred from Oklahoma to the company's office in Morgan City, La.

G. A. MUNSON

Gerald A. Munson is chief mineral engineer, Lithium Corp. of America Inc., Minneapolis. Mr. Munson will supervise the company's mining interests in the U. S. and Canada. Prior to joining the staff in 1951 to design and manage the mill at Hill City, S. D., Mr. Munson was consultant for the Lithium Corp. Last year he was general manager of the company's Bessemer City construction program.

Harold Howe has been elected secretary, American Smelting & Refining Co., New York. Mr. Howe joined the company in 1931 and was appointed assistant secretary in 1941.

George C. Trevorrow is now in Zonguldak, Turkey, with Paul Weir Co. Mr. Trevorrow was formerly general superintendent, Harmar Coal Co., Harmarville, Pa.

Harry L. Washburn is with Consolidation Coal Co. (W. Va.) Fairmont, W. Va. Mr. Washburn was with the Pittsburgh Consolidation Coal Co., Library, Pa.

Vernon K. Rising has left Salt Lake City and is now research metallurgist, Calera Mining Co., Cobalt, Idaho.

J. P. Sullivan, formerly of Goodman Mfg. Co., Pittsburgh, is now with Jess McNeel Inc., San Antonio, Texas.

J. S. Parsons has joined Pacific Smelting Co., Torrance, Calif., as assistant plant engineer. Mr. Parsons was formerly junior engineer, Western Pyromet Corp., Manteca, Calif.

Virgil E. Frank is assistant mine superintendent, Buchans Mining Co. Ltd., Buchans, Newfoundland.

W. E. Smith is assistant general sales manager, Dorr-Oliver Inc., Stamford, Conn.

C. O. Stephens, vice president and general manager of production, Texas Gulf Sulphur Co. Inc., is now at the company's office in Houston.

Wayne D. Jackson is a mining engineer for the Orinoco Mining Co., Ciudad Bolívar, Venezuela. Mr. Jackson was with Manganese Inc., Nevada. He was graduated from the Missouri School of Mines in 1952.

Lloyd C. White, consulting engineer, Berkeley, Calif., was in New York recently on a professional visit.

W. Van H. Smith is in the Research Div., Algom Uranium Mines Ltd., Algoma Mills, Ont. Mr. Smith was at the San Xavier mine, Tucson, Ariz., from 1948 to 1953, when he became manager, Dominion Aluminum Fabricating Ltd., Toronto. He then spent one session at the University of Toronto as instructor in mining, mine ventilation, and ore dressing. Mr. Smith was graduated from the University of Toronto.

Ian Cameron of King Island Scheelite Ltd., Grassey, King Island, Tasmania, was recently in the U. S. and visited the Mesabi iron range.

W. Lunsford Long of Warrenton, N. C., has been elected president of Haile Mines Inc., Tungsten Mining Corp., and Manganese Inc. Mr. Long, who has been vice president of the three companies since their organization, succeeds the late **Hewitt S. West** with whom he had been associated for 35 years. Mr. Long is also president of the Tungsten Institute.

George B. Kneass, mineral plant supervisor, Foote Mineral Co., has been transferred from Exton to Paoli, Pa.

Norbert F. Koepel, general manager, Andes Copper Mining Co., Potrerillos, Chile, has been appointed assistant general manager of South American operations for the Anaconda Co. and its subsidiaries, with headquarters at Potrerillos.

Ernest R. Achterberg is mining engineer, Baroid Sales Div., National Lead Co., Potosi, Mo. Mr. Achterberg was with Dowell Inc., El Dorado, Ark.

C. R. Sundeen is now with Cyprus Mines Corp., Bagdad, Ariz. Mr. Sundeen was with Cleveland-Cliffs Iron Co., Ishpeming, Mich.

Frank P. Shonkwiler has been named manager, basic sales, Harbison-Walker Refractories Co., with headquarters in Pittsburgh. Mr. Shonkwiler was on the Chicago district sales staff. He started with Harbison-Walker in 1943 in the research dept. and was transferred to the Chicago district in 1952.

Gerhard J. Grassmueck, production engineer, Lamaque Mining Co., Bourlamaque, Que., was on vacation in New York in September. Mr. Grassmueck has been with Lamaque for three years. He spent 14 years in Argentina and Chile doing exploration and development work.

The U. S. Dept. of the Interior Distinguished Service Award was presented to William E. Wrather, director of the U. S. Geological Survey, by Assistant Secretary Felix E. Wormser, on September 21. Left to right: Hugh A. Stewart, director, Office of Oil and Gas; C. O. Mittendorf, administrator, Defense Minerals Exploration Administration; Administrative Assistant Secretary D. Otis Beasley; J. Reuel Armstrong, solicitor; William E. Wrather; Raymond Davis, assistant to the Secretary; Assistant Secretary Felix E. Wormser; Spencer S. Shannon, Sr., director, Office of Minerals Mobilization; Thomas B. Nolan, assistant director, Geological Survey; Carroll D. Fentress, assistant director, Office of Oil and Gas; Thomas H. Miller, deputy director, U. S. Bureau of Mines; and John M. Wilkinson, director, Incentive Awards Staff.

G. W. Walkey is superintendent, Heath Steele Mines Ltd., Newcastle, N. B. Mr. Walkey was assistant general manager, Canadian Exploration Ltd., Salmo, B. C.

Eion E. Dando, sales representative, Aero Service Corp., Philadelphia, is now western manager for the corporation in San Francisco.

K. A. Young has joined Sherritt Gordon Mines Ltd., Chemical Metallurgical Div., Fort Saskatchewan, Alberta, as metallurgical engineer. Mr. Young was formerly with Cobalt Chemicals Ltd., Cobalt, Ont.

Tom S. Crouch is now with the Homestake Mining Co., Lead, S. D. He was formerly with Walsh Construction Co., Plant No. 10, Petoskey, Mich.

John L. Chapman is now a metallurgical consultant. His address is Route 3, Grand Junction, Colo. Mr. Chapman was director, Processing Div., U. S. Atomic Energy Commission, Grand Junction. From 1943 to 1950 Mr. Chapman was with Linde Air Products Co., Tonawanda, N. Y. He is a graduate of Colorado College and the University of Missouri.

Robert J. Goodwin is research engineer, Gulf Research & Development Co., Pittsburgh. Mr. Goodwin was associate technologist, The Texas Petroleum Research Committee, Texas Agricultural & Mechanical College, College Station.

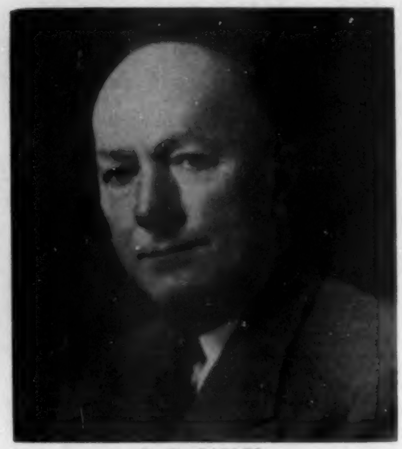
John R. Welch has been assigned by the U. S. Bureau of Mines as mining advisor to the Government of Nepal. He is now in Kathmandu. Mr. Welch was formerly with the Technical Cooperation Administration, U. S. Foreign Service, Tel Aviv, Israel.

I. G. Pickering is assistant mechanical engineer, Western Mining Divisions, Kennecott Copper Corp., Salt Lake City. Mr. Pickering was with Kennecott at Garfield, Utah.

John D. Bradley, president, Bunker Hill & Sullivan Mining & Concentrating Co., **Ross D. Leisk,** vice president and general manager, Sunshine Mining Co., **R. E. Sorenson,** vice president and chief engineer and geologist, Hecla Mining Co., and **Wallace G. Woolf,** manager, electrolytic zinc plant, Sullivan Mining Co., have been appointed to the research advisory council, University of Idaho, for the 1955 to 1957 biennium. **Harry W. Marsh,** secretary, Idaho Mining Assn., is also a member of the council.

Howard Steven Strouth, chief, Mining Div., Standard Ore & Alloys Corp., New York, has gone to Johannesburg, South Africa, to speed up mechanization of Standard's Palmiet chrome mine in the Transvaal.

Wilbur T. Stuart, formerly of the U. S. Geological Survey, Ishpeming, Mich., has been transferred to Washington, D. C.



R. B. CAPLES

Russel B. Caples has been elected vice president in charge of metallurgical operations, The Anaconda Co., New York. Mr. Caples is president, Anaconda Aluminum Co., and has been with Anaconda since 1910. From 1941 to 1953 he was general manager of the company's electrolytic zinc plant and copper refinery at Great Falls, Mont. Mr. Caples is a past president of the American Zinc Institute. He succeeds **Frederick Laist,** who has retired after 51 years of service with the Anaconda organization. **William Wraith, Jr.,** has been appointed assistant to Mr. Caples. Mr. Wraith has been with Anaconda since 1926 and was recently assistant general manager of Chile Exploration Co., Chuquicamata, Chile. He came to New York early this year.

W. WRAITH, JR.

E. L. Spencer has joined Pabco Products Inc., Lovelock, Nev., as resident engineer. Mr. Spencer will be in charge of opening a gypsum quarry and constructing a heavy media concentrating plant. He was with Westvaco Mineral Products Div., Food Machinery & Chemical Corp., Pocatello, Idaho.

William C. Miller is now area geologist, U. S. Atomic Energy Commission, Flagstaff, Ariz. Mr. Miller was district geologist, U. S. Engineer Office, Huntington, W. Va. He was there for 16 years.

L. A. ROE

Lawrence A. Roe has been appointed minerals beneficiation engineer, Engineering Div., International Minerals & Chemical Corp., Chicago. Before coming to International Mr. Roe was with the Bjorksten Research Laboratories, Madison, Wis., for four years. From 1947 to 1951 he was technical supervisor, Ore Research Div., Jones & Laughlin Steel Corp. In 1945 and 1946 Mr. Roe served in the Minerals Beneficiation Div., Battelle Memorial Institute, Columbus, Ohio. Prior to that he was with American Potash & Chemical Corp., Trona, Calif., for five years. Mr. Roe was graduated from the Missouri School of Mines and Metallurgy and completed two years of graduate work at the University of Wisconsin. He is the author of numerous technical papers.

J. H. HIRSHHORN

Philip D. Wilson, Joseph H. Hirshhorn, and **Gordon Dean** have joined the board of Callahan Zinc-Lead Co., New York. Mr. Wilson is a consulting mining engineer and geologist with Lehman Bros., New York. He is a director of the AIME. Mr. Hirshhorn is a director of Algom Uranium Mines Ltd. and Pronto Uranium Mines Ltd., Ontario. Mr. Dean is chairman of the board, Nuclear Science & Engineering Corp., and a senior vice president of General Dynamics Corp. He is also associated with Lehman Bros.

Henry I. Huang has been appointed assistant professor of metallurgy at the University of Idaho. Mr. Huang recently received his Ph. D. from the University of California.

George N. Decker is first vice president, Kellogg Div., American Brake Shoe Co. Mr. Decker, who joined Kellogg in 1944, will continue to be located in Rochester. **William H. Starbuck** is vice president of the Sintermet Div. He was formerly vice president of the Kellogg Div. He will now be located at Sintermet headquarters in Cleveland. **Fred L. Cogswell** succeeds Mr. Starbuck as vice president of the Kellogg Div. with headquarters in Rochester. Mr. Cogswell joined the company in 1935.

R. Earl Miller has been appointed to the newly created position of administrative assistant to **Jay J. Martin,** vice president in charge of operations, The Colorado Fuel & Iron Corp., Pueblo, Colo. Mr. Miller has been with CF&I's Pueblo plant for 28 years.

Jo Crosby is chief engineer, Mines Development Corp. Ltd., Salt Lake City. Mr. Crosby was with Newmont Exploration Ltd., Jerome, Ariz.

Robert M. Chapman of U. S. Geological Survey, College, Alaska, has been transferred to the Navy Oil Unit, USGS, Washington, D. C.

M. E. Volin is director, Michigan Bureau of Mineral Research, Michigan College of Mining & Technology, Houghton. Mr. Volin was chief, Branch of Base Metals, U. S. Bureau of Mines, Washington, D. C.

Immo H. Redeker has joined the research laboratory, Allis-Chalmers Mfg. Co., Milwaukee.

E. A. Schoeld, assistant research director, Potash Co. of America, Carlsbad, N. M., has been promoted to research superintendent. **David W. Goldsmith,** section supervisor, is now refinery and mill foreman.

Richmond M. Stampley is manager, Western Filtration Div., Dorr-Oliver Inc., with headquarters in Oakland, Calif.

Ralph L. Henry, assistant geologist, St. Joseph Lead Co., Flat River, Mo., is now chief engineer at the company's Edwards Div., Balmat, N. Y.

Daniel A. Jones has accepted an appointment as mining valuation engineer for the Bureau of Land Management with headquarters in Reno, Nev. Mr. Jones was formerly with Wah Chang Mining Corp. at the Benton mine near Bishop, Calif. Before coming to the States in 1954 he was with the Alaska Dept. of Mines in Nome. He had been mining engineer there since graduating from the University of Alaska in 1949.

OBITUARIES

Charles P. Berkey (Member 1908) died Aug. 22, 1955 at his home in Palisade, N. J. He was Newberry professor emeritus of geology at Columbia University and a pioneer in the application of geology to engineering. Mr. Berkey was born in Goshen, Ind., in 1867. He received a B.S. in 1892 and a Ph.D. in 1897 from the University of Minnesota. He joined the geology dept. at Columbia in 1903 and became head of the department in 1914. In 1906 Mr. Berkey began as a consulting geologist with the New York City Board of Water Supply and later was consultant for the water supply systems of Boston, Los Angeles, and other cities. He was an advisor on the location of many of the nation's largest dams, including the Hoover, Grand Coulee, Bonneville, and Norris. Other projects on which he was a consulting geologist include the George Washington Bridge, Lincoln Tunnel, and Tennessee Valley Authority. Mr. Berkey served as chief geologist for the Central Asiatic Expedition of the American Museum of Natural History in 1922 when the first fragments of a dinosaur egg were found. He was also chief geologist for the second Gobi expedition in 1925. After his retirement Mr. Berkey spent much of his time as a private consultant. At the request of the State Department he did irrigation surveys in Mexico and other South American and Central American countries. Mr. Berkey also served on the United Nations Site Committee. In 1948 he was awarded Columbia University's James Furman Kemp Medal. A member of many scientific and professional societies, Mr. Berkey was secretary of the Geological Society of America and in 1941 was the society's president.

Marcel Dupont (Member 1930) died July 24, 1955 of a hemorrhage near the heart as he was waiting for a plane at Lambert-St. Louis Airport. Mr. Dupont was a mining consultant and vice president of the Indussa Corp., New York. He was born in Belgium in 1891 and was graduated from the Ecole des Mines de Mons as a mining and electrical engineer. After working as an assistant engineer at Charbonnages Réunis, Charleroi, Belgium, Mr. Dupont went to North China where he was with the Chinese Engineering & Mining Co. Ltd. and the Linsi colliery. Later he was general manager of a colliery in Indochina, consulting engineer for Cie Générale Financière, Paris, and consulting engineer for the Philadelphia & Reading Coal & Iron Co., Philadelphia. After that Mr. Dupont was vice president and general manager, as well as consultant, Sadonia Ltd., an export company in New York.

Carleton C. Hascall (Member 1945) died June 2, 1955. He was a director and mining engineer for Longyear Realty Corp., Marquette, Mich. Mr. Hascall was born in Flint, Mich., in 1886 and received his E.M. from Michigan College of Mines and Technology in 1911. He remained at Michigan Tech as an instructor in the geology dept. until 1914 when he returned to Flint to become assistant metallurgist for Weston-Mott and Buick Motor Co. In 1917 Mr. Hascall joined Longyear Estate Inc. as mining engineer and geologist. He was a member of Tau Beta Pi and on the board of directors of the Alumni Assn. of Michigan Tech.

Morris F. LaCroix

An Appreciation by

Harold B. Ewoldt

Morris Felton LaCroix died July 28, 1955 at his home in Brookline, Mass. He was born in Lynn, Mass., Mar. 15, 1888, the son of Edward Wilton and Edith Lee (Morris) LaCroix. His early education was at Lawrenceville Academy and Volkmann School where he prepared for Harvard, earning his Bachelor's degree there in 1910. He then attended the Harvard Graduate School for Applied Science and was awarded a Master's degree in mining engineering in 1911. In that year he became

Necrology

Date Elected	Name	Date of Death
1934	Charles F. Allen	Unknown
1929	Henry A. Doerner	Unknown
1932	J. R. Gill	May 28, 1955
1903	Arthur L. Hamilton	Mar. 20, 1955
1900	L. Hanchett	Sept. 11, 1955
1948	J. J. Harroy	Aug. 5, 1955
1945	C. E. Higgins	Unknown
1925	James A. Hogle	Sept. 14, 1955
1931	R. B. Lane	Sept. 1955
1948	William C. Lenhardt	Unknown
1946	John V. Mangold	June 29, 1954
1940	Sydney Nashner	Aug. 15, 1955
1949	Earl J. Robishaw	Unknown
1911	Henry P. Smith	Sept. 4, 1955
1919	Haakon Styri	Sept. 13, 1955
1897	W. W. Taylor	May 25, 1955
1947	Henry E. Warren, Jr.	Sept. 16, 1955
1951	H. S. West	Sept. 2, 1955
1947	Joseph G. Wilson	August 1955
1952	H. C. Young	1953

associated with Cleveland-Cliffs Iron Mining Co. as an engineer and geologist at Ishpeming, Mich., and was elected to membership in the AIME. When World War I came he left this company to become a captain in the Corps of Engineers A.E.F. in France, returning as a major in 1919 after having been with the American Commission to negotiate peace in Paris.

Upon his return from France he joined the office organization of William A. Paine of Boston, investment bankers, investigating metal mining, coal, and oil properties and gradually working into the operating end of several mining and oil producing companies and into the underwriting part of the business of Paine, Webber & Co. At the time of his death Mr. LaCroix was a senior partner in the firm now known as Paine, Webber, Jackson & Curtis.

Mr. LaCroix acted as chief executive officer of Warren Bros., international road builders during construction of the Cuban Central Highway, and participated in the planning, design, and construction of Boulder Dam. He was instrumental in the development and financing of a bridge across the James River near Newport News, Va., and of the San Mateo Bridge south of San Francisco. Noted for his interest in telephone communications, he was chairman of the board of General Telephone Co., largest independent telephone concern in the nation, and director of International Telephone & Telegraph Corp. Morris LaCroix was gifted with great talents, logical mentality, and a very unusual capacity for useful and persistent work. He was a genial and considerate boss, a sincerely religious man whose creed was "You go to your church and I'll go to mine, but let us walk down the street together."

Morris was vitally concerned with educational progress. He was a member of the board of trustees of Smith College and maintained an active interest in Michigan College of Mines and Technology. He was recipient in 1954 of an honorary Doctor of Engineering degree from the latter institution.

In mining Morris' great adventure and romance was the Copper Range Co. and its two important subsidiaries, C. G. Hussey & Co. and White Pine Copper Co. As president of Copper Range Co. and White Pine Copper Co., he was directly responsible for the planning and development of the White Pine mine in Michigan's Upper Peninsula. This $70 million project, built to produce some 75 million lb of refined copper annually from a flat-lying bedded chalcocite deposit, comprises a completely modern mine, mill, smelter, and all related facilities together with a townsite to serve a population of some 2000 people.

Morris F. LaCroix was married in 1919 to Esther H. Paine of Swampscott, Mass., and to this union five children were born. The son, William Paine, died in 1950 as a result of injuries received in action on the *U.S.S. Bunker Hill* in World War II. The daughters are Ruth Ward (Mrs. Nelson Darling, Jr.); Jeanne (Mrs. Bigelow Crocker, Jr.); Susanne (Mrs. Richard D. Phippen); and Edith Morris (Mrs. John H. Knowles). Mrs. LaCroix was active in civic and charitable affairs in Boston until her death late in 1953. Morris LaCroix was a most considerate, kindhearted, and humble man, who gave freely of himself to help others. To those of us who knew and cherished his acquaintance, his companionship and his friendship, our loss will be tempered by the knowledge that remembrance of him and his deeds will remain fresh as long as memory lasts.

Gar A. Roush (Member 1914) died Aug. 16, 1955 in Arlington, Va. Mr. Roush was a mineral economist and metallurgist with the Federal Supply Service, Inspection Branch, Washington, D. C. He was born in Gas City, Ind., in 1883 and received his A.B. from Indiana University and his M.S. from the University of Wisconsin. Mr. Roush went to Lehigh University as assistant professor of metallurgy in 1912 and was associate professor from 1920 to 1926. He was acting professor of metallurgy, Montana School of Mines, from 1926 to 1927. Mr. Roush was editor from 1913 to 1943 of *The Mineral Industry*, an annual published by McGraw-Hill Book Co., and was an editor for the AIME in 1917. During World War I he served as a captain in the Ordnance Dept., U. S. Army, and later became a major in the Staff Specialist Reserve. Mr. Roush was awarded the Toulmin Medal of the Society of American Military Engineers for 1938. In 1943 he joined the U. S. Bureau of Mines as mineral technologist. The author of numerous scientific papers and sections in encyclopedias and technical books, Mr. Roush also contributed articles to *Military Engineer* on strategic mineral supplies in foreign countries.

Everett S. Shaw (Member 1946), consulting geologist of Denver, died June 30, 1955 while doing geological work in western Colorado. He was born in Hampton, N. H., in 1885 and received his B.S. from Yale University in 1912. Mr. Shaw then worked in Victor, Colo., as a mine surveyor for Stratton's Independence Mining & Milling Co. and later as mine foreman for Portland Gold Mining Co. From 1917 to 1932 Mr. Shaw was district geologist for Midwest Refining Co., Denver. He was geologist in charge of a field party for Yacimientos Petroliferous Fiscales, Buenos Aires, Argentina, from 1938 to 1941. Mr. Shaw was with United Geophysical Co., Pasadena, Calif., from 1942 to 1944 and was the geologist in charge of a field party in southern Chile.

Harry Townsend (Member 1920), mining geologist for The Anaconda Co., died in Ketchikan, Alaska, June 11, 1955. He was recovering from an emergency operation when he suffered a heart attack. Mr. Townsend was born in Kahoka, Mo., in 1886. After studying at Columbia University, he computed surveys for Lawyers Title Insurance & Trust Co., New York. In 1911 Mr. Townsend worked as assistant to B. D. Stewart, mining engineer in Juneau, Alaska. He was later transitman for Alaska Juneau Gold Mining Co. and mining engineer, Beatson mine, Kennecott Copper Corp., Latouche, Alaska. Following service in World War I with the Engineers as a lieutenant, Mr. Townsend joined Anaconda in 1919 as an assistant examining engineer. "Well known and highly respected in engineering circles in the Northwest," he was chairman of the North Pacific Section of the AIME and in 1949 vice chairman of Puget Sound Engineering Council.

MEMBERSHIP

Proposed for Membership
Mining Branch, AIME

Total AIME membership on Sept. 30, 1955 was 23,282; in addition 1939 Student Associates were enrolled.

ADMISSIONS COMMITTEE

P. D. Wilson, Chairman; F. A. Ayer, Vice-Chairman; A. C. Brinker, R. H. Dickson, T. D. Jones, F. T. Hanson, Sidney Rolle, O. B. J. Fraser, F. T. Sisco, Frank T. Weems, R. L. Ziegfield, R. B. Caples, F. W. McQuiston, Jr., A. R. Lytle, H. R. Wheeler, L. P. Warriner, J. H. Scaff.

The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

In the following list C/S means change of status; R, reinstatement; M, Member; J, Junior Member; A, Associate Member; S, Student Associate.

Alabama
Bessemer—Guyton, Jesse C. (M)
Birmingham—Castellitto, Thomas P. (M)
Birmingham—Clifton, Ben C. (A)
Birmingham—Humbard, Richard A. (A)
Birmingham—Lewon, Benjamin (M)
Birmingham—Tamblyn, Edwin W. (M)
Homewood—Hodnett, John W., Jr. (J)
Arizona
Clifton—Berry, Tom W. (M)
Clifton—Bonine, Norman C. (J)
Miami—Rucker, Gary O. (J)
Silver Bell—Krupp, Luther M. (J)

Arkansas
Little Rock—Dickinson, Haskell T. (A)
California
Altadena—Kellogg, William C. (R. C/S—J-M)
Boron—Fentnor, Louis H. (M)
San Francisco—Rawson, Richard R. (M)
Colorado
Grand Junction—Donnini, James M. (R. C/S—S-M)
Grand Junction—McRae, Otis M. (J)
Grand Junction—Rod, Thomas E. (A)
Ouray—Graves, Clarence E., Jr. (R. C/S—S-M)
Florida
Tallahassee—Bates, John D. (R. C/S—S-M)
Illinois
Chicago—Vaikutis, John P. (M)
Elmhurst—O'Connell, Jackson E. (A)
Kentucky
Wayland—Evans, George E., Jr. (M)
Michigan
Lake Linden—Vitton, John J. (M)
Negaunee—Randolph, Eskil R. (J)
Minnesota
Aurora—Young, Daniel H. (M)
Duluth—House, John E. (M)
Grand Rapids—Cofield, Gordon E. (M)
Missouri
Brentwood—Lake, Thomas R. (M)
Nevada
Boulder City—Mead, Tom C. (A)
Reno—Angulo, C. (J)
Winnemucca—Baldwin, Herbert W. (M)
New Jersey
Ridgewood—Moore, David L. (R. C/S—S-M)
New Mexico
Carlsbad—Abernathy, Charles W. (M)
Grants—Anikouchine, William A. (J)
New York
New York—Morris, Hugh C. (J)
North Creek—Decker, Howard W., Jr. (J)
Starlake—West, Frederick J. (M)
Wanakena—Vickers, William A. (M)
North Carolina
Henderson—Wigglesworth, Robert J. (M)
Kings Mountain—Flow, Ralph C. (C/S—J-M)
Ohio
Yellow Spring—White, John F. (C/S—A-M)
Oregon
Bend—Cochran, Gordon E. (J)
Eugene—Barton, Harold E. L. (M)
Salem—Bush, Boyd O. (M)
Pennsylvania
Glassmere—Kuchta, Bernard R. (J)
Lansdale—Schlotter, Charles W. (A)
Menges Mills—Jones, Carlton W. (M)
Pottsville—Sternick, Stanley P. (J)
Rimersburg—Welch, Dick W. (M)
Tennessee
Knoxville—Waddock, Francis B. (M)
Mt. Pleasant—Sullivan, Jay N. (M)
Texas
El Paso—Courson, William H. (R. A)
Utah
Lark—Bingham, Clarence P. (M)
Magna—Fraser, George L. (M)
Midvale—Johnson, Reed D. (M)
Moab—Nelson, Victor J. (M)
Monticello—Andrus, Niles J. (M)
Salt Lake City—Anderson, Edwin L. (M)
Salt Lake City—Egan, William J. (M)
Salt Lake City—Flatberg, Orrison M. (M)
Salt Lake City—Heiner, Keith P. (A)
Salt Lake City—Silver, Legrande C. (A)
Vermont
Montpelier—Frost, Robert A. (M)
Morrisville—Stewart, John K. (M)
Washington
Metaline Falls—May, Robert F. (R. C/S)
Seattle—Kelly, Hal J. (R. C/S—J-M)
Vancouver—Masterman, Earl W. (M)
West Virginia
Tralee—Shewmon, Daniel C. (C/S—J-M)
Wisconsin
Milwaukee—Halstead, Robert L. (M)
Argentina
Mendoza—Aparicio, Emiliano P. (A)
Bolivia
Oruro—Vogelsang, Pieter B. (C/S—A-M)
Canada
Ontario, Beardmore—McKay, George A. (M)
Ontario, Copper Cliff—Gaetz, Theodore M. (R. M)
Ontario, Toronto—Hutchison, William A. (M)
Ontario, Toronto—Sutherland, Don B. (J)
Ontario, Virginiatown—Fredeen, Sture R. (M)
Quebec, Sherbrooke—Holyk, Walter (M)
Chile
Sewell—Susie, Hal F. (M)
Greece
Myconos—Martin, Dan W. (J)
Jamaica, B.W.I.
Spur Tree P. O.—Hicks, George K. (M)
Peru
Lima—Gordillo D., Guillermo (M)
Lima—Paredes, Angel (M)
Trujillo—Stein, Hans H. (J)
Philippines
Davao City—Ybanez, Alfonso S. (M)
Switzerland
Geneva—Siegfried, Walter (M)

Coming Events

Nov. 15, AIME, National Open Hearth Steel Committee, Buffalo Section, 6th annual meeting, Royal Connaught Hotel, Hamilton, Ont.

Nov. 17-18, American Mining Congress, Coal Div. Conference, William Penn Hotel, Pittsburgh.

Nov. 22, AIME, Southeast Section, Birmingham. M. Siedenthal, speaker.

Nov. 27-30, American Institute of Chemical Engineers, annual meeting, Statler Hotel, Detroit.

Dec. 1, AIME, Utah Uranium Subsection, 7:30 pm, Arches Cafe, Moab, Utah.

Dec. 5, AIME, Arizona Section, annual meeting, Tucson, Ariz.

Dec. 5-9, 25th Exposition of Chemical Industries, Commercial Museum and Convention Hall, Philadelphia.

Dec. 7-9, AIME, Electric Furnace Steel Conference, William Penn Hotel, Pittsburgh.

Dec. 8, AIME, New York Section, President's Night, New York.

Dec. 9, AIME, Southeast Section, annual Christmas party, Birmingham.

Dec. 10-16, Atomic Exposition, Public Auditorium, Cleveland. Sponsored by the American Institute of Chemical Engineers in conjunction with the Joint Nuclear Congress.

Dec. 15, AIME, Ohio Valley Section, Battelle Memorial Institute, Columbus, Ohio. B. H. Alexander, speaker.

Dec. 26-31, American Assn. for the Advancement of Science, Atlanta.

Jan. 4-6, 1956, Fourth Annual Spectroscopy Seminar, University of Florida. For information write: Prof. W. T. Tiffin, College of Engineering, Gainesvile, Fla.

Jan. 25-27, Engineers Joint Council General Assembly, Statler Hotel, New York.

Feb. 2-3, Governor's Industrial Safety Conference, 6th annual statewide meeting, Fairmont Hotel. San Francisco. Mineral Extraction Section meets Feb. 2 and 3 at 1:00 pm.

Feb. 20-23, AIME, Annual Meeting, Statler and New Yorker hotels, New York.

Apr. 9-11, AIME, Open Hearth and Blast Furnace Conferences, Netherland Plaza Hotel, Cincinnati.

Apr. 9-11, Canadian Institute of Mining and Metallurgy, annual meeting, Chateau Frontenac, Quebec City.

Apr. 23-26, American Assn. of Petroleum Geologists, Conrad Hilton Hotel, Chicago.

May 3-5, AIME, Pacific Northwest Regional Conference, Olympic Hotel, Seattle.

May 7-9, American Mining Congress, Coal Convention, Netherland Plaza Hotel, Cincinnati.

June 16-23, Fifth World Power Conference, Vienna.

Feb. 24-28, 1957, AIME Annual Meeting. Roosevelt and Jung hotels, New Orleans.

Advertisers Index

* Previous Issues

Boosts haulage efficiency and increases safety...

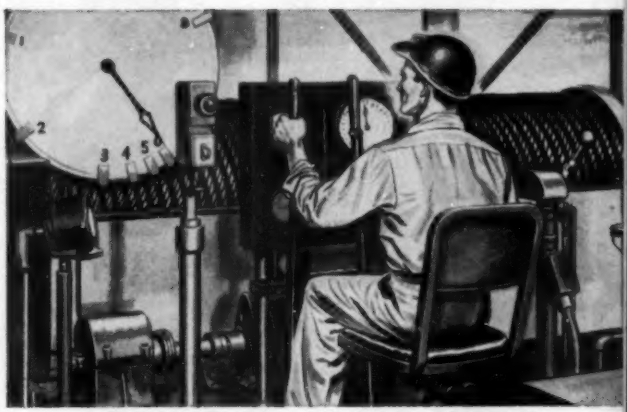
M·S·A MinePhone

The M.S.A. MinePhone is eliminating communication delays in mines everywhere. This clear, instant two-way voice communication system co-ordinates the wide variety of operations vital to peak production. Haulage moves faster because dispatcher and motormen are constantly in touch, even while trips are in motion. Shop and maintenance personnel are always "on call." And because messages are relayed instantly, on an open-line hookup, underground safety is increased. Write for details.

Assures accurate, safe, speedy hoisting operations...

M·S·A HoistPhone

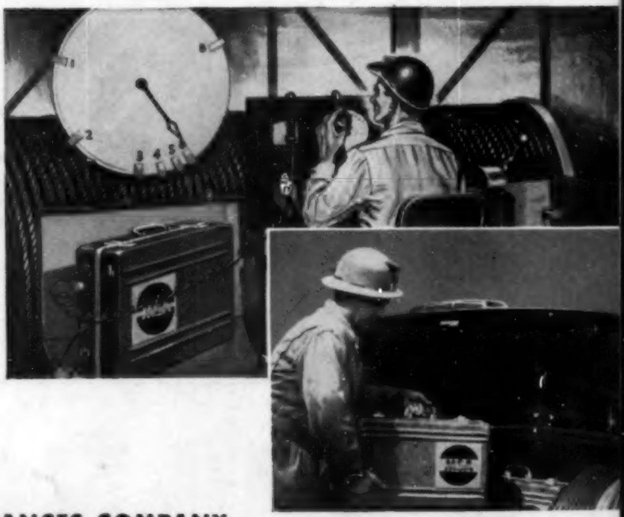
The M.S.A. HoistPhone provides continuous, dependable and efficient voice communication between hoisting engineer and cage, at any level, and when in motion. The system is invaluable in emergencies, yet designed for day-in-day-out service. Ideal for passenger travel, load leveling, inspection trips, and construction work, the HoistPhone requires no special training; utilizes existing wiring. Write for complete details.



Permits emergency or temporary communications...

M·S·A Portable HoistPhone

A compact, integral unit that can be set up anywhere, and put into immediate service for clear, dependable voice communications. Its light weight and ease of operation make it ideal for temporary communications for inspection work or for emergency assignments. Write for details.



MSA SAFETY EQUIPMENT HEADQUARTERS

When you have a safety problem, M.S.A. is at your service. Our job is to help you.

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pa.
At Your Service: 77 branch offices in the United States and Mexico

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
Toronto, Montreal, Calgary, Edmonton, Winnipeg, Vancouver, Sydney, N.S.